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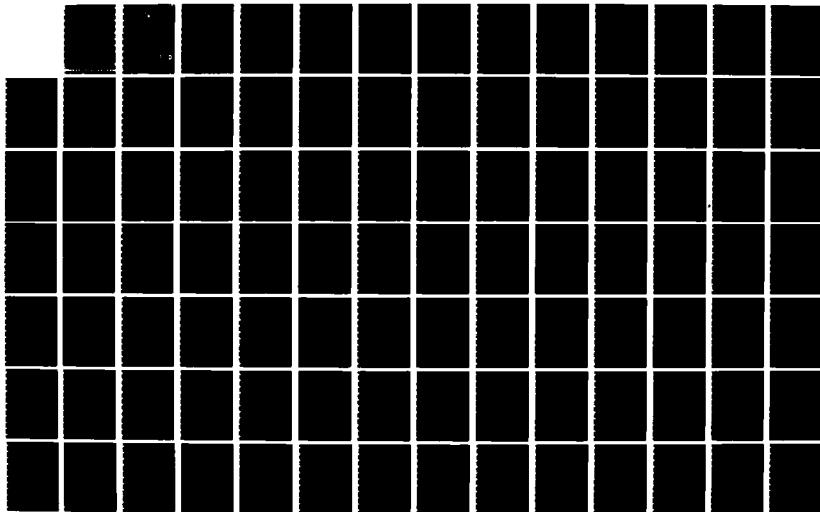
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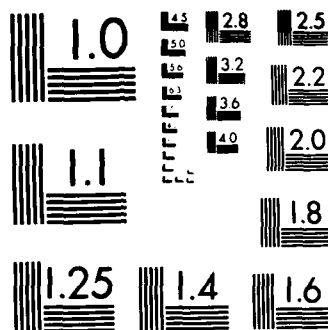
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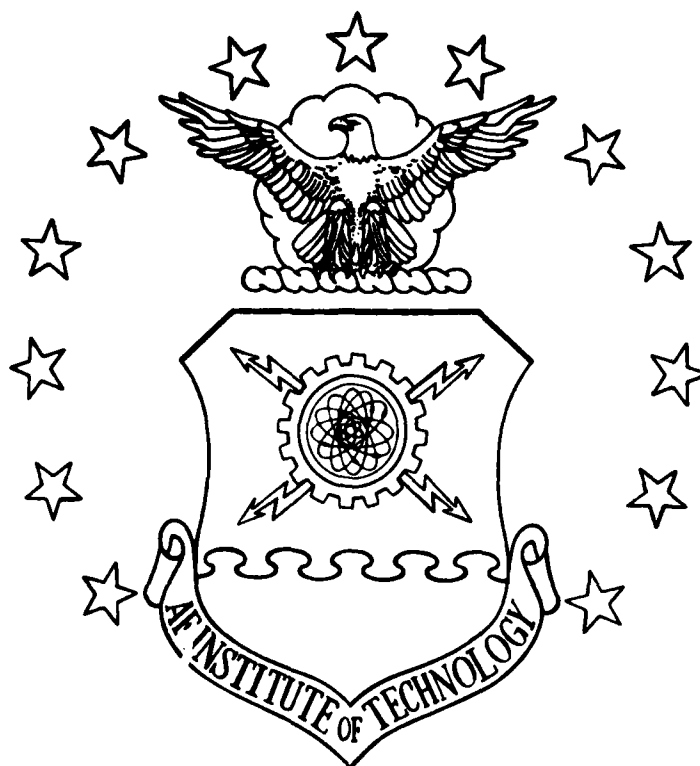




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EVALUATION OF AIR FORCE CIVIL  
ENGINEERING CONSTRUCTION INSPECTION

THESIS

Franklin L. Williams  
Captain, USAF

AFIT/GEM/LSM/86S-29

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EVALUATION OF AIR FORCE CIVIL ENGINEERING  
CONSTRUCTION INSPECTION

THESIS

Presented to the Faculty of the School of Systems and Logistics  
of the Air Force Institute of Technology

Air University

In Partial Fulfillment of the  
Requirements for the Degree of  
Master of Science in Engineering Management

Franklin L. Williams, B.S.

Captain, USAF

September 1986

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## Abstract

This study is an investigation to determine the perception of the effectiveness of Air Force construction inspection. In a 1985 study, the researcher identified excessive inspector workload, insufficient inspector training, and low inspector qualifications as potential problem areas for construction inspectors. However, due to limited data collection, the findings were not conclusive. This study attempted to validate/invalidate the previous findings by analyzing the returned opinion surveys from a larger sample population. The four research objectives were: 1) Determine the perceptions of the Air Force inspectors' job performance, 2) Determine the perception of the inspectors' job knowledge, 3), Determine if the training programs for the inspectors are adequate, and 4) Analyze the qualification requirements for inspectors. The opinion surveys were given to inspectors, inspector supervisors, design engineers, and contract administrators. The survey responses showed that the job performance of the inspectors is perceived to be positive overall. However, a significant number of individuals surveyed were concerned with the inspectors' experience, job knowledge, and capability to properly inspect the work. The results also showed that the training program for inspectors may not be adequate. Although the majority of the inspectors who attended the Contract Construction Inspectors Course believed it was helpful training, less than half of the

inspectors surveyed had attended the course. Both contract administrators and inspectors noted that additional inspector training was the most likely recommendation to improve the quality of inspection. Finally, contract management chiefs and inspectors believed that the qualifications for inspectors, such as requiring certification, should be increased.

# EVALUATION OF AIR FORCE CIVIL ENGINEERING CONSTRUCTION MANAGEMENT

## I. Introduction

The importance of effective management of United States Air Force construction projects continues to increase as the size of the Air Force construction budget grows. The total funding for the Operations and Maintenance (O&M) projects program grew from \$180 million in fiscal year 1979 (FY79) to \$629 million in FY84 (23:2). As the number of construction projects increases, the potential for higher litigation costs from construction disputes also increases. The magnitude of the construction disputes problem can be seen by examining the case load of the Air Force Directorate of Contract Appeals (AFLC/JAB). In a previous research effort, W.E. Merrill and L.J. Torchia noted: "At the end of 1981, JAB was handling approximately 100 construction cases with contractor claims totaling nearly \$16.3 million" (14:1). In many cases, these claims can be attributed to poor design and specification preparation, overloaded contract administrators, or inexperienced and inadequately trained construction inspectors (23:1-2).

By examining the specific area of construction management, factors which lead to contract management problems with construction inspectors may be determined. Once these

factors are known, changes could be recommended which could improve construction management effectiveness and thus reduce contract costs. This research effort is in response to the follow-up study recommendation made by Captain Robert Upshur in his thesis, Evaluation of Air Force Civil Engineering Construction Inspection and the Inspector (23). He recommended additional research in this area in order to validate/invalidate, using a large enough data base, the trends discovered in his study (23:57).

The following explanation of the Air Force construction process should aid in understanding the research analysis and findings.

#### Air Force Construction Process

A construction contract is a legal agreement between the Air Force and a private firm whereby the firm agrees to construct, modify, or repair facilities for an agreed upon consideration. The three phases of the process are design, contracting, and construction.

Design Phase. After a project is approved, engineers develop the drawings and specifications necessary to provide a facility that will meet the using organization's requirements. They also develop a construction cost estimate for use by the contracting officer during bid evaluation or negotiation.

Contracting Phase. Once the design is complete, the contracting officer uses the drawings and specifications as part of the solicitation as he/she tries to find a contractor

to do the specified work. After soliciting bids or proposals from eligible contracting firms, the contracting officer evaluates and awards the contract to the low, responsive, responsible bidder or proposer.

Construction Phase. Soon after the contract is awarded, the construction phase begins. Throughout this phase, it is the responsibility of the Civil Engineering construction inspector to monitor and inspect the contractor's work to insure the terms of the contract are met. Although the inspector cannot direct the work, he/she is the contracting officer's representative to identify immediately any problems or inconsistencies with the execution of the contract.

#### Research Problem

Since the intent of this research is to validate/invalidate the trends Captain Upshur discovered in his study, the research problem is naturally similar to the one Captain Upshur used to guide his research (23:5-6).

The purpose of the study is to determine the perception of the effectiveness of Air Force construction inspection. The approach to this study should determine if there are specific areas in which the inspector is not adequately prepared to manage construction projects.

#### Research Objectives

To solve the problem, four specific objectives guide the research:

1. Determine the perceptions design engineers, contract administrators, contract management chiefs, and inspectors have of the Air Force construction inspector's job performance.
2. Determine the perception of the inspector's job knowledge.
3. Determine if the training programs for the inspectors are adequate.
4. Analyze the qualification requirements for inspectors.

#### Scope and Limitations

This study deals with a broad subject and therefore will not identify and address all problem areas within the contract management section. The scope of the study is restricted by the following criteria:

1. This study is limited to examining only Air Force construction inspection and those inspectors at the base level. Military Construction Program projects are not included.
2. Only continental United States (CONUS) A.F. installations are included in the opinion survey.

## II. Literature Review

This chapter provides a more in-depth look at construction inspection and highlights the findings of previous construction inspection studies both within and outside of the Department of Defense. The following areas are presented: responsibilities of Air Force and civilian industry construction inspectors; previous construction inspection studies within and outside of the Air Force; and a review of key Armed Services Board of Contract Appeals (ASBCA) cases which were the result of construction inspection problems.

### Inspector Responsibilities

Air Force Regulation 89-1 (AFR 89-1), Design and Construction Management, "provides policies, procedures, and responsibilities for design and construction of Air Force structures and facilities" (5:1-1). The main purpose of construction inspection is to insure that the contractor adheres to approved plans and specifications and to ensure that the completed project provides a complete and usable facility which satisfies the approved using organization's requirements (5:13-1).

The construction inspector has many important responsibilities during the construction phase. The key responsibilities noted in AFR 89-1 follow.

The inspector must be knowledgeable in construction



practices to ensure recognition of improper construction (5:13-2). He/she should also be capable of reading plans and comprehending specifications (5:13-2). In addition, a thorough knowledge of applicable contracting regulations is necessary to evaluate whether or not the contractor is in compliance with the contract provisions (5:13-4).

The inspector is the "eyes and ears" of the contracting officer. He/she does not have the authority to direct work or change the scope of contract work since this is the responsibility of the contracting officer (5:13-4). If construction problems arise or a misunderstanding of contract provisions occurs, the inspector is responsible for initiating "conferences between the contractor, contracting officer and the construction manager to assist in the interpretation of the technical provisions and contractual documents" (5:13-2).

In addition to assuring compliance with contract plans and specifications, inspections are performed to:

- a. Avoid extra construction costs beyond the approved construction contract amount.
- b. Identify unforeseen field conditions, errors in drawings or technical specifications, elements overlooked in final drawings or specifications, and to insure the early correction of same.
- c. Maintain a daily record to provide accurate data for periodic reporting on contract status and construction progress and to establish written records of noncompliance or deviations from standards required to support Government (Air Force) in litigation.
- d. Eliminate the substitution of unacceptable materials, equipment, and craftsmanship.
- e. Prevent errors which might result in unnecessary and costly maintenance and upkeep costs.
- f. Skillfully coordinate the work if more than one prime contractor is working on the same facility.
- g. Protect the mutual interest of the Government

(Air Force) and contractor to produce a desired coordination of interests.

h. Prevent unfair practices and procedures, or attempts at avoidance of contractual obligations. The goal of the contract inspection effort is to assure the success of the construction project [5:13-1 to 13-2].

The article "Managing Construction Management" in the Air Force Engineering and Services Quarterly notes the inspector has responsibilities in four general areas. These are as an administrator, documentor, coordinator, and inspector (17:27).

As an administrator, the inspector keeps project files in order, reviews contractor material submittals, checks warranty information, and controls equipment operating instructions (17:27). He/she also reviews designs before they are sent to contracting to ensure the work specified can be accomplished and acts as the technical advisor to the contracting officer (17:27).

An important aspect of inspection is documentation in the daily diary (17:27). This information is used as a basis in determining contractor progress payments (17:27). Also, changes on the job site must be noted so that as-built drawings can be updated correctly after project completion (17:27).

The inspector acts as a coordinator between the base and the contractor (17:27). This coordination includes contract related utility outages and delivery of government-furnished material/equipment to the contractor (17:27).

The inspector's most important function is his/her actual inspection duties (17:27). He/she "checks for quality and

quantity as it relates to workmanship, equipment, materials, and compliance with contract documents" (17:27).

The responsibilities of Air Force inspectors are similar in many ways to those of an inspection team monitoring a project in private industry. James O'Brien highlights the specific duties of a typical inspection team in his book, Construction Inspection Handbook (15:7-8). These duties include:

1. Ensuring contractor compliance with plans and specifications.
2. Monitoring the project progress according to the schedule.
3. Coordinating contract reviews, approvals, and tests.
4. Interpreting contract drawings and specifications and documenting disputes.
5. Rejecting work which fails to meet contract requirements.
6. Approving contractor estimates of progress for progress payments.
7. Approving shop drawings, materials, and samples submitted by the contractor.

#### Construction Inspection Studies

The Committee on Inspection of the Construction Division of the American Society of Civil Engineers (ASCE) noted contractors and owners are dissatisfied with current construction practices and with the qualifications of inspectors (3:359). The Committee also noted it is estimated that problems with construction inspection are adding about \$500,000,000 annually to the cost of construction nationally

(3:359). As a result, studies have been undertaken to determine the specific problem areas. Since the intent of this research is to validate/invalidate the trends discovered in a similar study by Captain Upshur, Evaluation of Air Force Civil Engineering Construction Inspection and the Inspector, it is necessary to first summarize the results of his study (23).

Captain Upshur used an opinion survey, knowledge test, and information from current A.F. publications and reports to determine the answers to his research questions (23:19). His questionnaire was similar to one used in a previous survey by the American Society of Civil Engineers (23:20). The results of the ASCE survey will be addressed later this chapter. Because of a late survey approval, Captain Upshur's survey was not sent out to the field (23:23). His conclusions were based on responses from 37 individuals, most of whom were attending the Air Force Institute of Technology's School of Civil Engineering Contract Preparation and Management Course, MGT 425 (23:23). The more significant findings for each of his research questions follow.

To determine the perception of the inspector's job performance, "contract administrators, contract management supervisors, and design engineers were asked to agree or disagree with a number of subjective statements concerning the inspection field" (23:26). All three groups showed a strong indication that the construction inspector has a positive attitude toward his job and wants to see the contracted work

done properly (23:27). In reply to the statement "I find A.F. inspectors to be experienced and capable of properly inspecting construction work," replies from contract administrators were neutral, whereas CM supervisors (contract management chiefs) were more positive about the inspector's capabilities (23:27). The data indicated that design engineers believe the inspectors are capable of accurately reading plans and specifications (23:29). However, the engineers were inclined to believe the inspectors are not knowledgeable of current construction practices (23:28). In contrast, the inspectors' supervisors believe the inspectors are knowledgeable in their fields (23:28). Two-thirds of the inspectors surveyed believe their workload is too heavy (23:30). In contrast, the A.F. Civil Engineering Management Effectiveness Team report "Base Level Management Indicators for Civil Engineering and Services" did not provide support for the argument that the inspectors are overworked (23:30). Finally, the inspectors listed the number one cause of construction problems as poor specifications (23:34).

Captain Upshur analyzed the job knowledge of the inspector using results of tests given to students at the AFII Contract Preparation and Management course (23:37). From these results, he concluded "that inspectors do not appear to be as knowledgeable as they should be in the field" (23:55). He concluded the lack of knowledge may be because a number of inspectors are not being properly trained for the job (23:55). Finally, the data showed that experience had little effect on

the job knowledge of the inspectors or construction management supervisors (23:43).

To analyze A.F training programs for the inspector, "construction management supervisors and inspectors were surveyed to identify the training received as well as what training they perceived was needed" (23:43). Training was found to be accomplished by both informal training and formal training courses (23:43). Overall, the findings indicated there is not sufficient training for the base level inspector (23:55). For example, "of the contract management supervisors surveyed, sixty-seven percent had an in-house training program for their inspectors" (23:43). Informal training was usually provided as on-the-job training (23:43). The only formal Air Force training course for the inspector is the Construction Inspector's Course #JBZR55000 at Sheppard AFB TX. (23:44). Construction management supervisors estimated less than forty percent of their inspectors had attended the course (23:44). Captain Upshur concluded many base level inspectors are not being trained (23:56).

The last research objective was concerned with analyzing the qualifications of the inspector. Again, an opinion survey of contract administrators, CM supervisors, inspectors, and design engineers was used to summarize the perceptions of inspector qualifications (23:49). In general, "CM supervisors and inspectors indicated support for higher pay/position levels along with increasing the professional status of the inspector" (23:52). Also, the responses of all the survey

participants, with the exception of the inspector, indicated the inspector's authority for inspecting the work was sufficient (23:52). Captain Upshur also noted the results of the knowledge test showed that higher grade/ranked inspectors were more knowledgeable of construction management practices (23:56).

Since Captain Upshur's research was based on previous research done by the American Society of Civil Engineers, it is beneficial to examine the background and results of the ASCE study.

The Task Committee on Inspection was established by the American Society of Civil Engineers in the Spring of 1967 to "promote the development of criteria for upgrading personnel and practice in construction" (21:219). The goal of the Committee was to determine what the on-site construction inspection problems were and then recommend solutions to these problems (21:219). This was accomplished by conducting a national field survey which confirmed the existence of many problems (21:219). Included in the survey were personnel from the Army Corps of Engineers, the Naval Facilities Engineering Command, and the Air Force (21:221). Published in 1972, the Committee's findings included the following key issues.

Forty-one percent of the responses from the owners and owner representatives indicated that most inspection problems are related to incompetent inspection personnel (21:224). Twenty-six percent of the owners believed problems are related to incompetent contractor personnel and 33 percent indicated

that the problems are related to policy and conditions which include:

1. Low fees and low salaries;
2. poor specifications;
3. contractors cutting corners;
4. owners not realizing the importance of funding for good, full time inspection; and
5. uneven workloads make it difficult to maintain a permanent staff [21:226].

Seventy-six percent of the contractors responded that they do not believe inspectors have the necessary experience to properly inspect their work (21:229). Ninety-five percent of the explanations given by contractors are grouped into five categories which are (21:230):

1. Unfamiliarity with construction practices (55%).
2. Inspectors' low salary (15%).
3. Lack of educational background (11%).
4. Inspectors' inability to interpret specifications (8%).
5. Incompetent inspectors (6%).

To emphasize the need for the evaluation of construction inspectors, Captain Upshur cited the results of a 1979 U.S. Army Audit Agency audit of 14 construction and service contracts totalling \$2.1 million (23:14). Six of the contracts awarded for a total of \$1.1 million had serious deficiencies which were primarily caused by a lack of inspector documentation (23:14).

The Proceedings of a 1984 symposium sponsored by the Construction Division of the American Society of Civil Engineers, "Professional Inspection of Construction," noted



widespread complaints regarding inspector performance. These included:

1. Insufficient formal educational and technical training.
2. Inadequate jobsite inspector indoctrination and training.
3. Inability or unwillingness to make contract interpretations which leads to the stereotype inspector image of "going by the book."
4. Inability to fully understand and comprehend specifications [12:12].

It is clear from the literature that there are costly problems in the area of construction inspection. In order to better understand some of the typical problems encountered with inspection, a review of selected Armed Services Board of Contract Appeals cases (ASBCA) is provided.

#### Armed Services Board of Contract Appeals Cases

Because of double-digit inflation, the uncertainty of the construction industry, and the fierce competition for bids, parties to construction contracts are becoming more "claims oriented" [25:376].

This section reviews two ASBCA cases and shows that contractor disputes could have been avoided through proper construction inspection.

ASBCA No. 20791, August 20, 1976. The case involved Cox Craft, Inc., in a situation where an inspector ordered work done which was not required by the contract (2:57997). The inspector believed the plaster installed by the contractor on the swimming pool steps was unsatisfactory and had to be reaccomplished (2:57994). However, it was found that this plaster work did meet specifications (2:57993-57994). In

order to redo the work on the steps, the swimming pool had to be partially drained. In addition, the pool was ordered drained two more times by the inspector for inspection and cleaning, despite the contractor's warning that the new plaster in the pool had to remain under water at all times to allow proper curing (2:57994). During the one-year warranty, the plaster started to come off. However, the Board did not support the Government's claim against the contractor for repairs since Government error was a contributing factor to the problem (2:57996-57997).

ASBCA No. 18450, November 28, 1975. In a case involving the Spencer Construction Company, Inc., the inspector instructed the contractor to accomplish extra work in digging test pits and removing sand, gravel, and peat at the work site. Since the extra work was not covered in the contract, the contractor appealed to the Board for payment for this work. The Board awarded an adjustment to the contractor for the digging because the inspector was acting as the authorized representative of the contracting officer (1:55460-55426).

#### Summary

The construction inspector has a key role in ensuring a contractor adheres to approved plans and specifications so that the completed project provides a complete and usable facility. He/she must be capable of reading plans and specifications, knowledgeable of construction practices to ensure recognition of improper construction, and have a

thorough understanding of applicable contracting regulations. However, the inspector does not have the authority to direct work or change the scope of a contract since that is the responsibility of the contracting officer.

Previous studies have shown that there may be inspector problems both within (23) and outside of the Air Force (21). Research by the American Society of Civil Engineers concluded that owners and owner representatives believe that most inspection problems are related to incompetent inspection personnel (21:224). A recent Air Force study concluded "that inspectors may not be as knowledgeable as they should be in the field" (23:55). Further analysis of Air Force construction inspection is necessary to determine if there is indeed a problem with the effectiveness of the inspector.

### III. Methodology

The purpose of this chapter is to present the methodology used to collect and analyze the data necessary to meet the research objectives. Opinion surveys, as well as additional data from Air Force publications and reports, were used in the study. A survey was selected since "one can seldom learn much about opinions and attitudes except by questioning" (7:158). Because of the size of the population and their geographical dispersion, the mailed questionnaire was chosen as the best method of data collection (7:172).

The opinion survey is a four-part questionnaire administered to sample elements consisting of contract management chiefs, construction inspectors, contract administrators, and design engineers.

Initially, a knowledge test was to have been included with the opinion survey for construction inspectors. The purpose of the test was to compare the knowledge levels of the inspectors having different training and experience in support of research objective two. However, the test was deleted because the validity of this approach was questionable for several reasons. First, it was not possible to insure that the test questions would accurately measure the knowledge level of the inspectors. Second, individuals taking the test could not be prevented from obtaining outside help. Finally, the addition of the test to the opinion questionnaire would

have made the survey too long to be practical.

The results of the opinion surveys, coupled with information available from existing publications, provide the information necessary to determine the perception of the effectiveness of Air Force construction inspection.

### Questionnaire

Development. The questionnaires for this thesis are very similar to the questionnaire used by Captain Upshur in his thesis, Evaluation of Air Force Construction Inspection and the Inspector (23:60-63). They are also similar to a 1970 survey conducted by the American Society of Civil Engineers (21). The questionnaires used in this study are presented in Appendix A. The validity of the questionnaires was established by its use in the two previous research efforts. In addition, the questionnaires were reviewed and critiqued by an experienced construction inspector. The following two sections show the content of the questionnaires.

Demographics. The first section of the questionnaires contains demographic questions that request the following information:

1. Enlisted/Officer/Civilian
2. Grade
3. Experience in construction field
4. Present position
5. Years in present position
6. Education level

7. Professional certification

Opinions. The second section of the questionnaires requests opinions from all survey participants. All participants were asked to agree or disagree with a number of statements concerning the following areas:

1. The need for inspectors
2. Inspectors' general competence
3. Inspectors' general work attitude
4. Inspectors' job experience
5. Inspectors' job knowledge
6. Degree of seriousness of most common inspection problems
7. Likelihood certain recommendations will improve quality of inspection

Additional opinions were solicited from each of the four groups of participants in the following areas:

1. From contract administrators:
  - a. Contractors' general impression of inspectors
  - b. Inspectors' authority
  - c. Inspectors' abuse of authority
2. From design engineers:
  - a. Inspectors' knowledge of current construction techniques and practices
  - b. Inspectors' capability of interpreting drawings and specifications
  - c. Inspectors' use of design engineers as consultants
  - d. Need for additional inspector training
3. From the Chiefs, Contract Management:

- a. Inspector workload
  - b. Inspector position classification and salary
  - c. Inspector certification and/or semi-professional status
  - d. Inspector knowledge of current construction techniques and practices
  - e. Inspector authority
  - f. Inspector training courses
  - g. Need for additional inspector training
4. From construction inspectors:
- a. Inspector workload
  - b. Inspector position classification and salary
  - c. Inspector certification and/or semi-professional status
  - d. Inspector authority
  - e. Inspector training courses
  - f. Need for additional inspector training

Population and Sample. The populations of interest for this survey consist of Air Force contract administrators, design engineers, contract management chiefs, and construction inspectors at all CONUS Air Force bases. The population sizes are (24,18):

- 1. Contracting administrator personnel: 420
- 2. Civil engineering design personnel: 1182
- 3. Civil engineering Chief, Contract Management: 86
- 4. Civil engineering construction inspectors: 970

Initially, the researcher considered generalizing the

results of the study to the four populations statistically with a 95% confidence level. However, assuming a 50% survey return rate (13), 1632 surveys would need to be sent to insure the sample sizes were large enough for this confidence level. The sample sizes for the confidence levels were calculated using HQ USAF/ACM's "A Guide For the Development of Attitude and Opinion Survey" (4:11-14). After considering the costs in time and resources for such a large sample, the researcher determined the objective of the study could be met by making logical inferences with a smaller sample size rather than statistical inferences.

#### Data Collection

The researcher determined 60 bases would be surveyed to meet the subjective goal of 30 responses from the chiefs of contract management, the smallest population of interest. Three design engineers, three construction inspectors, and three contract administrators were also surveyed at each base. Again, the researcher subjectively selected the number three per population per base. The surveys for the contract administrators were sent to the Chief, Contracting, at each base with the request to randomly distribute the surveys to three contract administrators who were responsible for construction contracts. The surveys for the civil engineering Chief, Contract Management, three design engineers, and three construction inspectors were sent to the Chief, Engineering and Environmental Planning, at each base with the request for



random distribution. The two letters requesting the random distribution of surveys are shown in Appendix B.

The 60 bases in the survey were randomly selected from each major command using the same proportion as the number of contract management sections in the command to the total number of CONUS contract management sections. The list of bases selected for the survey is shown in Appendix C.

Due to an administrative problem, one base was later dropped from the survey list so only 59 bases were actually surveyed. Also, approval from the Labor-Relations Management Office to survey civilian employees at Kirtland AFB NM was not given so only military personnel were surveyed at that base.

#### Data Analysis

The statistical package SPSSx was used to determine the frequencies and relative percentages for those who 1) Strongly Disagree, 2) Disagree, 3) Remain Neutral, 4) Agree, and 5) Strongly Agree with the subjective opinion statements (20). Frequencies and relative percentages were also used to determine the degree of seriousness of common inspection problems and the likelihood that various recommendations would improve the quality of inspections. The problems and recommendations which were evaluated were then ranked using the Borgadus scale (9:244). Other Air Force sources, such as previous reports or studies, were also introduced to strengthen or weaken possible conclusions.

#### IV. Results and Analysis

This chapter provides an analysis of the data collected by the questionnaires to satisfy the four specific research objectives: 1) Determine the perceptions of the Air Force inspectors' job performance, 2) Determine the perception of the inspectors' job knowledge, 3) Determine if the training programs for the inspectors are adequate, and 4) Analyze the qualification requirements for inspectors. The percentages shown in the tables have been rounded to the nearest percent. Due to rounding, the sum of percentages for each group is 100 plus/minus one percent.

This chapter is divided into five sections. The first section provides demographic information for the individuals responding to the survey. Each of the four remaining sections provides an analysis of one of the four research questions.

##### Demographics of Survey Participants

Individuals from 59 CONUS Air Force bases were selected to receive questionnaires. The random selection processes for both the bases and the individuals participating in the survey are described in Chapter III.

The number of individuals surveyed and the return rates for each sample element follow:

	<u>Surveys Sent</u>	<u>Surveys Received</u>	<u>Return Rate</u>
Contract administrator	177	146	82%
Design engineer	177	138	78%
Chief, Contract Mgt	59	41	69%
Inspector	177	133	75%

Demographic information is provided for individuals from each sample element who responded to the surveys.

Contract Administrator. Contract administrators who participated in the survey had the following characteristics:

<u>Rank/Grade</u>	<u>Enlisted</u>	<u>Officer</u>	<u>Civilian</u>
E1-4, O1, GS7/below	12	3	9
E5, O2, GS8	25	0	0
E6, O3, GS9	17	2	40
E7, O4, GS10/11	6	2	27
E8-9, O5, GS12/above	0	0	3
Total	60	7	79

<u>Highest Education Level</u>	<u>Percent</u>
High School	43%
Associate degree	25%
Baccalaureate degree	18%
Masters degree	6%
Other	8%

<u>Professional Certification</u>	<u>Percent</u>
Certified Professional Contracts Manager (NCMA)	1%
Certified Associate Contracts Manager (NCMA)	1%
Professional Designation in Contract Management (AFIT/NCMA)	2%
Other	11%
None	85%

Very few of the 15 individuals responding to the question  
"other" listed the other professional certifications held.

<u>Time in Contracting Field</u>	<u>Percent</u>
Less than two years	9%
Two to four years	17%
Four to eight years	30%
Eight to twelve years	17%
More than twelve years	27%

<u>Time As Contract Administrator</u>	<u>Percent</u>
Less than six months	7%
Six months to one year	12%
One to three years	32%
Three to five years	15%
More than five years	34%

<u>Attended AFIT Contract Preparation and Mgt Course</u>	<u>Percent</u>
Yes	3%
No	97%

Enrollment in the Air Force Institute of Technology Contract Preparation and Management Course, Mgt 425, has been open to contract administrators since October 1985. According to the course director, contract administrators have provided valuable insights into construction problems from the contracting officer's point of view (16).

Contract administrators responding to the survey appear to be experienced. The majority of these individuals were civilian and nearly 40% of them were in the grade GS 10 or higher. In addition, over one third had more than five years experience as a contract administrator.

Design Engineer. Design engineers who participated in the survey had the following characteristics:

<u>Rank/Grade</u>	<u>Enlisted</u>	<u>Officer</u>	<u>Civilian</u>
E1-4, O1, GS7/below	0	13	6
E5, O2, GS8	5	18	7
E6, O3, GS9	0	3	14
E7, O4, GS10/11	3	0	44
E8-9, O5, GS12/above	0	0	25
Total	8	34	96

The respondents' military/civilian mix of 30% military/70% civilian is reasonably close to the authorized CONUS mix of 34% military/66% civilian (18). Eight of the participants were enlisted and therefore, were more likely to be engineering assistants than engineers. However, the enlisted personnel responses were considered after making the

assumption that they were involved in the design process because of their selection by the Chief, Engineering and Environmental Planning, to complete the survey.

<u>Highest Education Level</u>	<u>Percent</u>
High School	11%
Associate degree	8%
Baccalaureate degree	69%
Masters degree	9%
Other	3%

<u>Specialty</u>	<u>Percent</u>
Mechanical engineer	19%
Electrical engineer	13%
Civil Engineer	32%
Architect	18%
Other	18%

<u>Professional Certification</u>	<u>Percent</u>
Engineer-In-Training/ Intern Architect	43%
Professional Engineer/ Registered Architect	25%
Other	8%
None	24%

Only six of the 33 individuals who answered the question "other" listed the other certification. Of the six, five were Engineering Technicians and one was an Interior Designer.

<u>Time in Civil Engineering</u>	<u>Percent</u>
Less than two years	24%
Two to four years	31%
Four to eight years	17%
Eight to twelve years	7%
Twelve years or more	21%

<u>Time As Design Engineer</u>	<u>Percent</u>
Less than six months	13%
Six months to one year	16%
One to three years	27%
Three to five years	16%
More than five years	28%

<u>Attended AFIT Contract Preparation and Mgt Course</u>	<u>Percent</u>
Yes	25%
No	75%

The design engineers appear to have a broad range of specialties and time in design. Nearly 25% are Professional Engineers/Registered Architects and more than 40% of them have at least three years design experience.

Chief, Contract Management. The contract management chiefs who participated in the survey had the following characteristics:

<u>Rank/Grade</u>	<u>Enlisted</u>	<u>Officer</u>	<u>Civilian</u>
E1-4, 01, GS7/below	1	0	1
E5, 02, GS8	0	4	0
E6, 03, GS9	0	1	1
E7, 04, GS10/11	1	1	12
E8-9, 05, GS12/above	1	0	18
Total	3	6	32

<u>Highest Education Level</u>	<u>Percent</u>
High school	7%
Associate degree	7%
Baccalaureate degree	63%
Masters	17%
Other	5%

<u>Professional Certification</u>	<u>Percent</u>
Engineer-In-Training/ Intern Architect	18%
Professional Engineer/ Registered Architect	18%
Other	12%
None	52%

<u>Time In Civil Engineering Field</u>	<u>Percent</u>
Less than two years	7%
Two to four years	24%
Four to eight years	15%
Eight to twelve years	7%
More than twelve years	46%



<u>Time As Chief, Contract Management</u>	<u>Percent</u>
Less than six months	17%
Six months to one year	8%
One to three years	32%
Three to five years	13%
More than five years	30%

<u>Attended AFIT Contract Preparation and Mgt Course</u>	<u>Percent</u>
Yes	50%
No	50%

Based on survey responses, the Chief, Contract Management, is generally an engineer/architect. Seventy-five percent of these individuals had at least one year in this position. In addition, nearly one-third of them had been a section chief over five years.

Construction Inspector. The inspectors who participated in the survey had the following characteristics:

<u>Rank/Grade</u>	<u>Enlisted</u>	<u>Officer</u>	<u>Civilian</u>
E1-4, O1, GS7/below	7	1	26
E5, O2, GS8	18	4	19
E6, O3, GS9	9	3	19
E7, O4, GS10/11	11	0	10
E8-9, O5, GS12/above	2	0	4
Total	47	8	78

The military/civilian mix of the survey participants

is 40% military/60% civilian. This is reasonably close to the authorized CONUS mix of 45% military/55% civilian (18). The average grade of the civilians responding to the survey is approximately GS 7.8. This compares favorably with the average civilian inspector grade from four selected major commands. The 1986 average grades for these commands are: Strategic Air Command - GS 7.20, Tactical Air Command - GS 7.74, Military Airlift Command - GS 7.75, Air Force Logistics Command - GS 8.64 (10). The military respondents also appear representative of the military population of inspectors. For example, the military grade having the most inspectors is E5 with 37% (18). The largest number of military survey respondents for one grade was 34% for E5.

<u>Highest Education Level</u>	<u>Percent</u>
High school	38%
Associate degree	27%
Baccalaureate degree	19%
Masters degree	2%
Other	14%

<u>Professional Certification</u>	<u>Percent</u>
Engineer-In-Training/ Intern Architect	8%
Professional Engineer/ Registered Architect	4%
Other	21%
None	67%

Only five of the 27 individuals who answered the question "other" listed the other certification. Of the five, four were Engineering Technicians and one was a Land Surveyor.

<u>Time In Civil Engineering</u>	<u>Percent</u>
Less than two years	9%
Two to four years	17%
Four to Eight years	21%
Eight to twelve years	15%
Twelve years or more	38%

<u>Time As An Inspector</u>	<u>Percent</u>
Less than six months	6%
Six months to one year	9%
One to three years	31%
Three to five years	19%
Five years or more	35%

<u>Attended AFIT Contract Preparation and Mgt Course</u>	<u>Percent</u>
Yes	22%
No	78%

Based on the military/civilian mix, experience, and the grades of the individuals responding to the survey, the sample element of inspectors appears to represent the total population of inspectors.

Considering the demographic information for all four sample elements, it is logical to assume that these sample

elements represent their respective populations reasonably well.

#### Research Objective One

Perception of Performance. To determine the perception of the inspector's job performance, contract administrators, design engineers, and contract management chiefs were asked to agree or disagree with a number of subjective statements concerning the construction inspection field. The statement and responses follow.

Statement: Construction inspectors play a critical role in the overall success of a construction contract.

The responses to this statement were very positive.

	<u>Strongly Disagree</u>	<u>Disagree</u>	<u>Neutral</u>	<u>Agree</u>	<u>Strongly Agree</u>
Contract Administrators	4%	0%	2%	32%	62%
Design Engineers	2%	2%	2%	26%	68%
Contract Mgt Chiefs	5%	3%	0%	17%	75%

Over 90% of the respondents from each of the three groups either agreed or strongly agreed with the statement. This indicates there is a definite need perceived for the construction inspector.

Statement: Air Force inspectors are cooperative and interested in seeing that the contracted work is accomplished properly.

The responses to this statement were positive.

	<u>Strongly Disagree</u>	<u>Disagree</u>	<u>Neutral</u>	<u>Agree</u>	<u>Strongly Agree</u>
Contract Administrators	3%	4%	22%	57%	14%
Design Engineers	2%	5%	10%	52%	31%

Although both groups generally agreed with this statement, design engineers were stronger in agreement. The positive responses indicate that the inspector is conscientious and has a good attitude toward his/her job.

Statement: I find A.F. inspectors to be experienced and capable of properly inspecting construction work.

The responses vary among the different groups.

	<u>Strongly Disagree</u>	<u>Disagree</u>	<u>Neutral</u>	<u>Agree</u>	<u>Strongly Agree</u>
Contract Administrators	5%	23%	26%	42%	4%
Design Engineers	7%	20%	30%	38%	5%
Contract Mgt Chiefs	0%	19%	15%	51%	15%

Although there were more positive than negative responses for all three groups, a significant number of individuals were neutral or in disagreement. This suggests there is some doubt about the inspector's capabilities in the field.

This statement generated additional comments from thirty contract administrators. The majority of them cited unqualified and inexperienced inspectors as a problem. Eight of the contract administrators noted that often inspectors who are capable of properly inspecting in one trade are assigned to projects unrelated to their expertise. Three individuals

stated that inspectors assigned temporarily from the C.E. shops usually do not know how to inspect.

Statement: Contractors at my base generally agree that A.F. inspectors possess the experience necessary to properly inspect their work.

Only contract administrators responded to this statement.

	<u>Strongly Disagree</u>	<u>Disagree</u>	<u>Neutral</u>	<u>Agree</u>	<u>Strongly Agree</u>
Contract Administrator	6%	25%	30%	35%	4%

Over 60% of the responses were neutral or in disagreement.

This indicates that contractors do not have a strong, positive perception of the inspectors capabilities. Twenty-nine contract administrators provided additional comments. Nearly all of them noted that they had several complaints from contractors about the lack of experience and technical competence to properly inspect work.

Statement: Many contractors have stated that they welcome inspection by competent A.F. inspectors because it assures the work is getting done with less chance of delays and costly errors. In my opinion, contractors at my base would agree.

Only contract administrators responded to this statement.

	<u>Strongly Disagree</u>	<u>Disagree</u>	<u>Neutral</u>	<u>Agree</u>	<u>Strongly Agree</u>
Contract Administrators	3%	7%	19%	55%	16%

Contract administrator responses were very positive to this statement. It appears the key word is "competent" since responses are much more positive than in the previous

statement.

Statement: Inspectors continually consult with the designer during the project's construction phase.

Design engineers only responded to this statement.

	<u>Strongly Disagree</u>	<u>Disagree</u>	<u>Neutral</u>	<u>Agree</u>	<u>Strongly Agree</u>
Design Engineers	6%	12%	24%	39%	19%

Generally, inspectors consult with the designer during the construction phase. It appears that this consultation contributes to improving the perception engineers have of the inspectors' capability. For example, nearly 75% of the engineers who agreed that the inspectors were experienced and capable of properly inspecting work also agreed that the inspectors continually consult with the designers. In contrast, only 41% of the the engineers who did not agree that the inspectors were experienced and capable of properly inspecting work agreed that inspectors continually consult with the designers.

Factors Effecting Performance. To better understand the perceptions of the inspector's job performance, factors effecting this performance are further analyzed. These factors include inspector authority and workload. In addition, constructability reviews are addressed as a possible factor effecting the inspectors performance.

Authority. Two questions which deal with the inspectors authority were included in the survey.

Statement: I believe the inspectors are given sufficient authority to carry out their duties.

All groups of survey participants responded to this statement. The statement directed to the the inspectors and contract management chiefs was worded slightly different, but had the same intent.

	<u>Strongly Disagree</u>	<u>Disagree</u>	<u>Neutral</u>	<u>Agree</u>	<u>Strongly Agree</u>
Contract Administrators	1%	8%	13%	63%	15%
Design Engineers	15%	28%	16%	37%	5%
Contract Mgt Chiefs	19%	42%	15%	19%	5%
Inspectors	31%	34%	8%	26%	1%

The responses from each of the groups were quite varied. Only the contract administrators were in strong agreement with the statement. The overall response from the design engineers was neutral, but there was significant variance in their responses. Both the inspectors and the contract management chiefs expressed fairly strong disagreement. One of the problems identified in the PROJECT IMAGE Construction Management Functional review in June 1986, was a lack of inspector authority (11). As a result, the PROJECT IMAGE Working Group is studying a recommendation to allow inspectors to authorize no cost/no time changes and changes up to \$2500 (19).

Statement: Air Force inspectors at times obligate the government without authority to do so.



Only contract administrators responded to this question.

	<u>Strongly Disagree</u>	<u>Disagree</u>	<u>Neutral</u>	<u>Agree</u>	<u>Strongly Agree</u>
Contract Administrators	1%	9%	13%	63%	15%

Nearly 80% of these individuals believed the inspectors obligate the government without having the authority to do so. This appears to be one reason a large number of contract administrators responded negatively to the earlier statement concerning inspectors being capable of properly inspecting construction work. Nearly 90% of the contract administrators who responded negatively to the earlier statement concerning inspector capabilities also believed inspectors obligate the government without authority to do so.

Workload. Since the workload can influence an inspectors performance, information and opinion statements concerning workloads are presented.

Inspectors and contract management chiefs provided information on the average number and total value of Operations and Maintenance (O&M) and Military Construction Program (MCP) funded projects assigned to an inspector at any given time.

<u>Number of O&amp;M Projects Assigned</u>	<u>Percent (Inspectors)</u>	<u>Percent (Section Chiefs)</u>
One to five	47%	29%
Six to nine	38%	59%
Ten to thirteen	8%	12%
Fifteen or more	6%	0%

<u>Average Total Dollar Value For O&amp;M Projects (M-million)</u>	<u>Percent (Inspectors)</u>	<u>Percent (Section Chiefs)</u>
Less than .5M	16%	10%
.5M to 2M	52%	68%
2M to 4M	18%	15%
4M or more	8%	5%
Unknown	5%	2%

<u>Average Number of MCP Projects Assigned</u>	<u>Percent (Inspectors)</u>	<u>Percent (Section Chiefs)</u>
Zero	14%	10%
One	43%	39%
Two	17%	15%
Three	10%	10%
Four or more	16%	22%
Unknown	0%	5%

<u>Average Total Dollar Value For MCP Projects (M-million)</u>	<u>Percent (Inspectors)</u>	<u>Percent (Section Chiefs)</u>
Zero	14%	5%
Less than 3M	60%	29%
3M to 10M	16%	41%
10M to 15M	2%	3%
15M or more	8%	15%
Unknown	0%	7%

Inspectors responded that their duties are limited to:

<u>Inspector Duties</u>	<u>Percent</u>
Construction duties only	43%
Both Construction Inspection and Quality Assurance Evaluation	43%
Other	14%

The contract management chiefs and inspectors were asked to agree/disagree with a statement concerning workload. For the inspectors:

Statement: As an inspector, I believe my workload is too heavy.

For the contract management chiefs:

Statement: I feel that my inspectors have too heavy a workload.

	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
Contract Mgt Chiefs	0%	19%	15%	51%	15%
Inspectors	3%	21%	36%	25%	15%

Although the overall response to the statements were positive for both groups, the contract management chiefs were much stronger in agreement. A significant number of responses from both groups were neutral or in disagreement. Over 85% of the inspectors were assigned nine O&M projects or less and nearly half of the inspectors reported that they had five O&M projects or less. The total O&M dollar value for the majority of the inspectors was under \$2 million. The majority of the inspectors were also assigned surveillance responsibilities

for up to two Military Construction Program projects.

In his research effort, Captain Upshur cited facts concerning inspector workload from the 1985 Air Force Civil Engineering Management Effectiveness Team report "Base Level Management Indicators For Civil Engineering and Services" (23:30). This report noted the A.F. average is six projects per inspector (23:30). It also stated that inspectors should be able to effectively handle six-to-eight projects (23:30). It appears the majority of the inspectors surveyed were in the six-to-eight project range, but at least 10% had 10 or more O&M projects assigned.

Constructability Reviews. Air Force Regulation 89-1 places the responsibility of performing a constructability review in the contract management section. Since these reviews usually lead to interaction with the design engineer, it is possible that these reviews may be an indicator for the perception of the inspectors job performance. Three of the groups responded to two statements concerning constructability reviews.

Statement: Do inspectors at your base make constructability reviews?

The responses are:

	<u>Yes</u>	<u>No</u>	<u>Unknown</u>
Design Engineers	83%	6%	11%
Contract Mgt Chiefs	95%	2%	2%
Inspectors	84%	14%	2%

The great majority of inspectors do perform these reviews.

Statement: Inspectors generally make valuable recommendations as a result of their constructability reviews.

The responses are:

	<u>Strongly Disagree</u>	<u>Disagree</u>	<u>Neutral</u>	<u>Agree</u>	<u>Strongly Agree</u>
Design Engineers	4%	12%	24%	48%	12%
Contract Mgt Chiefs	2%	7%	2%	63%	24%
Inspectors	3%	3%	5%	55%	34%

There was an overall positive response to this question, particularly with the inspectors and contract management chiefs. This positive response seems to indicate that the inspectors are perceived as doing this portion of their job in a professional manner.

Problem Areas. All the participants were asked to evaluate four potential problems in terms of how much of a problem each problem was in their respective organizations. In addition, they were given the opportunity to specify and evaluate another problem of their choice.

The responses to the problem of "poor specifications and drawings" follow:

	<u>Major Problem</u>	<u>Moderate Problem</u>	<u>Minor Problem</u>	<u>Not A Problem</u>
Contract Administrators	77%	18%	3%	2%
Design Engineers	15%	37%	33%	15%
Contract Mgt Chiefs	45.5%	45.5%	5%	0%
Inspectors	47%	33%	18%	2%

Over 50% of the respondents considered this a moderate to major problem. It is interesting to note that the contract administrators had the strongest negative response, while the response from engineers, who develop drawings and specifications, was much less negative.

The responses to the statement concerning "problems related to contractor personnel" follow:

	<u>Major Problem</u>	<u>Moderate Problem</u>	<u>Minor Problem</u>	<u>Not A Problem</u>
Contract Administrators	1%	31%	48%	20%
Design Engineers	15%	44%	33%	8%
Contract Mgt Chiefs	17%	41%	37%	5%
Inspectors	18%	37%	41%	4%

Only a few of the respondents considered this a major problem, but the majority indicated it was a minor to moderate problem.

The responses to the problem of "contractors cutting corners" follows:

	<u>Major Problem</u>	<u>Moderate Problem</u>	<u>Minor Problem</u>	<u>Not A Problem</u>
Contract Administrators	5%	27%	48%	20%
Design Engineers	19%	33%	39%	8%
Contract Mgt Chiefs	19%	39%	32%	10%
Inspectors	18%	38%	38%	6%

The replies from the three groups from civil engineering were similar. They believed this problem was more serious than did the contract administrators.

Only contract administrators, design engineers, and

contract management chiefs responded to the statement concerning "problems related to inspection personnel."

	<u>Major Problem</u>	<u>Moderate Problem</u>	<u>Minor Problem</u>	<u>Not A Problem</u>
Contract Administrators	11%	31%	43%	15%
Design Engineers	10%	28%	36%	26%
Contract Mgt Chiefs	10%	20%	45%	25%

Approximately ten percent of the respondents considered this a major problem and over 50% indicated this was a minor problem or not a problem. These results appear fairly consistent with the replies to previous a statement dealing with inspector's experience and inspection capabilities.

Only inspectors responded to the "problem with job conditions (i.e., low salaries attracting unqualified inspectors and heavy inspector workloads)."

	<u>Major Problem</u>	<u>Moderate Problem</u>	<u>Minor Problem</u>	<u>Not A Problem</u>
Inspectors	26%	32%	22%	19%

Over 50% of the inspectors believed this was a moderate to major problem.

Nearly 40% of the survey participants noted there were "other" problems and the majority of them listed these problems.

The 46 contract administrators who provided additional comments covered a wide area of problems. As a group, no single problem was noted more than three times with one exception. Five contract administrators stated poor design

reviews by engineers was a major problem. Some of the other typical responses were:

1. Too heavy inspector workload
2. Inexperienced or poorly trained inspectors and engineers
3. Slow response and decision making from civil engineering
4. Lack of qualified inspection supervision
5. Lack of coordination with using agencies
6. Too many "rush" jobs.

There was no dominant problem given in the 47 design engineer responses. As with the contract administrators, a wide variety of types of problems were provided. The problem noted most often was the lack of training and experience by the inspectors. The shortage of inspectors and excessive inspector workloads were also listed several times. Other typical problems were:

1. Competence of contracting personnel
2. Too many change orders
3. Rushed designs
4. Proper coordination with using organizations or design agent
5. Change order process too slow
6. Contractor/inspector attitude conflicts
7. Adequate design review time.

Four of the twelve contract management chiefs who listed "other" problems cited too heavy of a workload for inspectors. The remainder of the responses covered several items and these



included:

1. Lack of transportation
2. Lack of technical expertise
3. Inadequate as-built drawings
4. Military duty commitments.

Forty-five inspectors listed "other" problems. Again, there was no single problem named by the majority of the respondents. The two problems listed most often were difficulties working with the contracting office (11 times) and the lack of engineering support (eight times). The lack of experience/training and low grades were also noted several times. Additional problems identified included:

1. Not enough priority given to constructability reviews
2. Lack of authority
3. Low bid contractors
4. Temporary overhires
5. Poor A-E designs
6. Using agency interference

The four problems which were evaluated were ranked from most to least serious for each group by the use of a Borgadus scale (9). The responses for the choice of "other problems" were not included in the ranking since there were no dominant single responses by any of the groups. To arrive at a numerical value for ranking the problems, a value was subjectively assigned to each of the four possible responses. The response "major problem" was given a three, "moderate problem" was given a two, "minor problem" was given a one, and

the response "not a problem" was given a zero. These values were then multiplied by the percentages of individuals who selected each of the four respective responses. For example, if 30% of the responses were "major problem," 40% were "moderate problem," 20% were "minor problem," and 10% were "not a problem," the numerical value for ranking would be:

$$(30 \times 3) + (40 \times 2) + (20 \times 1) + (10 \times 0) = 190.$$

The numerical value and the rank of the four problems for each of the groups follow:

	<u>Contract Admin</u>	<u>Design Engineer</u>	<u>Contract Mgt Chief</u>	<u>Inspector</u>
Poor drawings/ specifications	270 (#1)	152 (#3)	242 (#1)	225 (#1)
Contractor personnel problems	113 (#4)	166 (#1)	170 (#2)	169 (#2)
Contractor cutting corners	117 (#3)	162 (#2)	167 (#3)	163 (#4)
Inspection personnel	138 (#2)	122 (#4)	115 (#4)	---
Inspector job conditions	---	---	---	164 (#3)

Poor drawings/specifications was selected by a strong margin as the most serious inspection problem for contract administrators, contract management chiefs, and inspectors. Only design engineers differed by indicating this was their third most serious problem in a close tabulation. Problems with inspection personnel was the second most serious problem for contract administration. In contrast, the other two groups evaluating this problem, design engineers and contract management chiefs, found this to be their least serious

problem. Inspectors found problems with inspector job conditions to be their least serious problem. However, the inspectors' numerical values for the bottom three problems were very close.

Recommendations For Improvement. All the participants were asked to evaluate four recommendations for improving the quality of Air Force construction inspection. In addition, they were given the opportunity to evaluate another recommendation of their choice. The possible responses for the evaluation were: 1) Very likely to improve inspections, 2) Slightly likely to improve inspections, 3) Neither likely nor unlikely to improve inspections, 4) Slightly unlikely to improve inspections, or 5) Very unlikely to improve inspections.

The responses to the recommendation "increase design engineer participation" follow:

	<u>Very Likely</u>	<u>Slightly Likely</u>	<u>Neither</u>	<u>Slightly Unlikely</u>	<u>Very Unlikely</u>
Contract Administrators	52%	27%	12%	4%	5%
Design Engineers	57%	25%	12%	2%	4%
Contract Mgt Chiefs	38%	35%	9%	9%	9%
Inspectors	59%	32%	3%	3%	3%

Three of the four groups strongly believed that this recommendation would improve construction inspection. Only the contract management chiefs had less than 50% of the responses stating "very likely to improve inspections." Of

the four groups, the responses from the contract management chiefs and the inspectors differed the most.

The responses to the recommendation for "higher grade structure for the inspector" follow:

	<u>Very Likely</u>	<u>Slightly Likely</u>	<u>Neither</u>	<u>Slightly Unlikely</u>	<u>Very Unlikely</u>
Contract Administrators	27%	30%	27%	3%	12%
Design Engineers	47%	24%	20%	5%	4%
Contract Mgt Chiefs	71%	22%	0%	2%	5%
Inspectors	59%	24%	13%	2%	2%

Support for this recommendation was considerably higher for the three groups from civil engineering than for the contract administrators.

The responses to the recommendation for "more inspectors (i.e., reduced individual workload, but increased inspection on all projects)" follow:

	<u>Very Likely</u>	<u>Slightly Likely</u>	<u>Neither</u>	<u>Slightly Unlikely</u>	<u>Very Unlikely</u>
Contract Administrators	63%	19%	12%	2%	8%
Design Engineers	55%	24%	14%	4%	3%
Contract Mgt Chiefs	57%	27%	8%	5%	3%
Inspectors	67%	19%	7%	4%	3%

All four groups strongly believed that having more inspectors would improve construction inspection.

The responses to the recommendation for "additional inspector training" follow:

	<u>Very Likely</u>	<u>Slightly Likely</u>	<u>Neither</u>	<u>Slightly Unlikely</u>	<u>Very Unlikely</u>
Contract Administrators	79%	23%	5%	1%	2%
Design Engineers	55%	24%	14%	4%	3%
Contract Mgt Chiefs	61%	32%	5%	2%	0%
Inspectors	80%	17%	1%	1%	0%

Although the majority of the participants responded that additional training was very likely to improve construction inspection, the responses from the contract administrators and inspectors were particularly strong.

The number of individuals who noted there were "other" recommendations ranged from a low of 17% for inspectors to a high of 35% for contract management chiefs. Many of these individuals listed their recommendations on the questionnaire.

The recommendations listed by the 34 contract administrators were quite varied. Only four recommendations were suggested by more than one individual. The recommendation listed most often (five times) was to increase the training of inspectors in contract law. This was followed by the recommendation to improve relations/communications between civil engineering and contracting (four times). Other recommendations included:

1. More involvement by contract management supervisors
2. Reduce quantity of designs and improve design quality
3. Require inspector experience in design or construction
4. Improve specifications/drawings

5. Move inspection responsibility to contracting
6. Increase design reviews by inspection personnel
7. Increase vehicle availability

Only two recommendations were suggested by more than any two of the 31 design engineers providing additional recommendations. The action most recommended was to increase inspector authority (seven times). Four engineers believed that specialized inspection (i.e., electrical works, mechanical works, etc.) would improve the quality of Air Force inspection. Additional recommendations included:

1. Improve attention to constructability reviews
2. Provide more technical reference material
3. Provide training in working with contractors
4. Authorize additional vehicles
5. Require inspector certification
6. Reduce inspector paperwork
7. Reduce number of temporary overhires
8. Improve coordination with design engineers.

Twelve of the contract management chiefs provided a wide range of additional recommendations. The recommendation most named (three times) called for increasing the number of civilian inspectors due to military continuity problems and military duty conflicts. Two individuals suggested that an increase in vehicles would improve the quality of inspection. Other recommendations included:

1. Improve constructability review process

2. Spread the workload evenly throughout the year
3. Require inspector certification
4. Increase inspector authority
5. Assign an engineer in each discipline to Contract Management to work as a lead inspector.

Twenty-one inspectors listed "other" recommendations.

Again, there was no single recommendation named by the majority of the respondents. The two recommendations listed most often were to increase inspector authority (three times) and eliminate temporary overhires (three times). Additional recommendations included:

1. Adopt a project team concept
2. Use specialized inspectors (i.e., mechanical works, electrical works, etc.)
3. Improve inspector design reviews
4. Train new design engineers by assigning them to contract management for one year
5. Increase vehicle authorization
6. Improve relations with contracting office
7. Assign more engineers to inspection.

The four recommendations which were evaluated were ranked from most likely to most unlikely to improve the quality of construction for each group. The responses for the choice "other" recommendations were not included in the ranking since there were no dominant single responses by any of the groups. To arrive at a numerical value for ranking the recommendations, a value was subjectively assigned to each of the four possible responses. The response "very likely" was

given a two, "slightly likely" was given a one, "neither" was given a zero, "slightly unlikely" was given a minus one, and "very unlikely" was given a minus two. These values were then multiplied by the percentages of individuals who selected each of the five respective responses. For example, if 30% of the responses were "very likely," 25% were "slightly likely," 20% were "neither," 15% were "slightly unlikely," and 10% were "very unlikely," the numerical value for ranking would be:

$$(30 \times 2) + (25 \times 1) + (20 \times 0) + (15 \times -1) + (10 \times -2) = 50.$$

The numerical value and the rank of the four problems for each of the groups follow:

	Contract Admin	Design Engineer	Contract Mgt Chief	Inspector
Increase engineer participation	117 (#3)	129 (#1)	84 (#4)	141 (#3)
Higher grades for inspector	57 (#4)	105 (#4)	155 (#1)	136 (#4)
More inspectors	127 (#2)	124 (#2)	128 (#3)	143 (#2)
Additional inspector training	176 (#1)	124 (#2)	150 (#2)	176 (#1)

Providing additional inspector training was the recommendation selected by the contract administrators and inspectors as most likely to improve the quality of construction inspection. This recommendation was ranked second after the recommendation for higher inspector grades by contract management chiefs. The recommendation for higher inspector grades was the fourth choice for the other three groups. It is important to note that the numerical values for the bottom three inspector recommendations were so close, the



recommendations were for the most part equally likely to improve the quality of inspection.

#### Research Objective Two

To determine the perceptions of the inspectors' job knowledge, design engineers, contract management chiefs, and inspectors were asked to agree or disagree with questions concerning knowledge levels. The statements and responses follow.

Statement: Air Force inspectors are knowledgeable of current construction techniques and practices.

The design engineers and contract management chiefs were asked to respond to this statement.

	<u>Strongly Disagree</u>	<u>Disagree</u>	<u>Neutral</u>	<u>Agree</u>	<u>Strongly Agree</u>
Design Engineers	7%	22%	33%	33%	5%
Contract Mgt Chiefs	0%	20%	24%	49%	7%

The overall response was more positive than negative for both groups. However, the responses from the contract management chiefs were much more positive.

A similar statement was included in the inspector survey to determine how they perceived their group as a whole.

Statement: I find the technical knowledge level for inspectors in general to be high.

The responses to this statement are:

	<u>Strongly Disagree</u>	<u>Disagree</u>	<u>Neutral</u>	<u>Agree</u>	<u>Strongly Agree</u>
Inspectors	5%	20%	17%	42%	16%

Although the majority of the individuals agree that the technical knowledge level for inspectors is high, a significant number (25%) did not agree.

Since the capability to accurately interpret design drawings and specifications is a necessity for competent construction inspections, design engineers were asked to agree or disagree with the following statement:

Statement: Air Force inspectors are capable of accurately interpreting design drawings and specifications.

They responded:

	<u>Strongly Disagree</u>	<u>Disagree</u>	<u>Neutral</u>	<u>Agree</u>	<u>Strongly Agree</u>
Design Engineers	5%	17%	27%	43%	8%

The design engineers expressed a similar, but slightly more positive, opinion to this statement than to the earlier statement concerning the inspectors' knowledge of current construction techniques and practices. However, it is important to note that over 20% of these individuals did not agree with the statement.

### Research Objective Three

To determine if the training programs for inspectors are adequate, information and opinions were collected from design engineers, contract management chiefs, and inspectors. This data is presented in the following sections: in-house training, formal training, and additional training requirements. In addition, PROJECT IMAGE recommendations to

improve inspector training are addressed.

In-House Training. Contract management chiefs and inspectors were asked to respond to the use and sufficiency of in-house training programs.

Statement: My section has an "in-house" training program for construction inspectors.

The replies follow:

	<u>Yes (Percent)</u>	<u>No (Percent)</u>
Contract Mgt Chiefs	66%	34%
Inspectors	26%	74%

The responses from the two groups appear to conflict. Since the individuals surveyed were from the same bases, the percentages should have been similar. However, this is not the case. One possible reason for the difference is that the inspectors were unaware of the in-house training programs. It is also possible that the concepts of an in-house training program are different for the two groups (such as ongoing training rather than initial or on-the-job training).

Individuals who had an in-house training program were asked to provide a brief description of the program. Nearly all of the fifteen contract management chiefs outlined some type of on-the-job training program, which was primarily for new personnel. In most of these programs, the individual works with a trainer for some period of time before being assigned his/her own projects. Once assigned a project, the new inspector is watched by a more experienced inspector until

he/she demonstrates the knowledge to work independently. Many of the contract management chiefs also noted that they had an established training guide outlining policies and procedures for performing inspections. Finally, several chiefs indicated that they had weekly sessions to discuss job related topics.

Nine of the 19 inspectors providing an explanation of their in-house training programs also cited on-the-job training. Seven individuals noted that their section had weekly or monthly training sessions given by inspectors with expertise in different areas. In addition, a few inspectors responded that their sections had locally developed training manuals.

Statement: I believe the use of an "in-house" training program provides sufficient training for construction inspectors.

The responses to this statement follow:

	<u>Strongly Disagree</u>	<u>Disagree</u>	<u>Neutral</u>	<u>Agree</u>	<u>Strongly Agree</u>
Contract Mgt Chiefs	10%	66%	19%	5%	0%
Inspectors	21%	45%	15%	14%	5%

Both the contract management chiefs and the inspectors strongly believe training beyond only an "in-house" program is necessary for the inspectors.

Formal Training. The first part of this section provides a description of two Air Force training courses that inspectors primarily attend. Then, the number of inspectors attending formal training courses and the reasons for/for not

attending the courses are examined.

Formal Course Descriptions. The Contract

Construction Inspector's Course, #J3A2R55070, is held at Sheppard AFB TX, and it is the only Air Force training course designed specifically for the inspector (23:43). The training includes the inspector's role, microfilm retrieval system, construction management regulations, Base Civil Engineering/Contracting Interface, contract documents, documentation, constructability review, performance conference, material submittals, progress acceptance procedures, construction safety, service contracts, site work, asphalt, concrete, masonry, metals, thermal and moisture protection, woods, finishes, doors, windows, mechanical, electrical, quality assurance evaluation, and blueprint reading (22). The six week course has an average class size of 20-25 students and is offered five times a year (23:48). The thesis prepared by Captain Upshur contains a detailed outline of the actual material taught in the course (23).

The Air Force Institute of Technology's Contract Preparation and Management Course, MGT 425, is held at Wright-Patterson AFB OH, and is primarily for designers, design supervisors, and contract managers. However, the attendance by construction inspectors is considered on a space available basis. The course description follows:

The fundamentals of government contracting, such as the Federal Acquisition Regulation, contract law and contracting coordination are stressed. The basics of specifications, including methods, organization, writing and coordination, are presented and applied. In

addition, the basics of managing construction and service contracts, including inspection, documentation, and legal remedies are presented [6:272].

Formal Course Attendance/Adequacy. The contract management chiefs were asked what percentage of their inspectors attended the Contract Construction Inspector's Course. They responded as follows: 1) 36% thought less than 25% of their inspectors attended the course, 2) 17% thought between 26% and 50% of the inspectors attended the course, 3) 15% thought between 51% and 75% of their inspectors attended the course, and 4) 22% thought more than 75% of their inspectors attended the course. The remaining 10% of the contract management chiefs were unsure. Forty-four percent of the inspectors surveyed had attended the the Contract Construction Inspector's Course. There appears to be an unequal distribution of inspectors from the different bases who attended the course. This is seen by the fact that 36% of the sections had less than 25% of their inspectors attending the course, while 22% of the chiefs thought more than 75% of their inspectors had attended. The responses from both groups indicate that the majority of the inspectors have not attended the course.

Two questions were included in the survey to determine the reasons for/for not attending the course. The contract management chiefs responded that their primary reasons for course attendance were: 1) 13% responded course slots were available, 2) 10% responded the workload was not too heavy to release inspectors to attend the course, 3) 59% responded

material covered in the course contributes greatly to inspector's performance, and 4) 18% responded "other." The "other" reasons were not noted by the respondents. The results show that the primary reason inspectors attend the course is its value in improving job performance.

Availability of course slots was the primary reason contract management chiefs/inspectors gave as the reason their inspectors/they had not attended the course. The results are:

	Percent (Inspector)	Percent (Section Chief)
Not enough available course slots	34%	27%
Too heavy workload to release inspectors	18%	27%
Material covered in course not worthwhile	5%	---
Not aware of course	13%	0%
Other	29%	27%
Unknown	---	19%

The responses contract management chiefs included as "other" reasons were varied. They included:

1. Available slots and workload are an equal problem
2. Course too long
3. Not enough rank/time
4. Lack of funds
5. Temporary overhires not authorized to attend

Only a small number of inspectors provided "other" reasons and the one given most often was temporary overhire ineligibility.

The problem of some bases having a large number of temporary overhires who are ineligible for this training was identified in the June 1986 PROJECT IMAGE Construction Management Functional Review. This functional review working group is studying solutions to this problem (11). In addition, the report "Engineering Management Study of the Air Force Design and Construction Management Establishment" noted that the assignment of individuals with low grades as inspectors precludes them from qualifying for many formal training courses (8:2-208)

Statement: I believe the training provided by the Contract Construction Inspector's Course #J3A2R55000 at Sheppard AFB TX is helpful training for most inspectors.

Contract Management chiefs and inspectors generally agreed with this statment.

	<u>Strongly Disagree</u>	<u>Disagree</u>	<u>Neutral</u>	<u>Agree</u>	<u>Strongly Agree</u>
Contract Mgt Chiefs	2%	5%	27%	63%	2%
Inspectors	5%	8%	37%	34%	16%

Overall, both groups had a positive response to the usefulness of this course. However, there were a large number of neutral opinions and this may be due to unfamiliarity with the course. The responses from only the 59 inspectors who attended the course follow:



	<u>Strongly Disagree</u>	<u>Disagree</u>	<u>Neutral</u>	<u>Agree</u>	<u>Strongly Agree</u>
Inspectors	7%	9%	7%	48%	29%

Over three-fourths of the inspectors who attended the Contract Construction Inspectors Course believed it was helpful training.

Twenty-nine of the inspectors (22%) attended the Contract Preparation and Management Course (MGT 425). Only these individuals responded to the following statement.

Statement: I believe the training provided by the Contract Preparation and Management Course, MGT 425, AFIT School of Civil Engineering, is helpful training for all inspectors.

They responded:

	<u>Strongly Disagree</u>	<u>Disagree</u>	<u>Neutral</u>	<u>Agree</u>	<u>Strongly Agree</u>
Inspectors	3%	3%	7%	62%	24%

Over 85% of the inspectors who attended the course believed it was helpful training

Both groups were asked if the two courses provided most of the training construction inspectors require. However, the results are not presented since they appear inconclusive due to the large number of neutral responses.

Fifty-nine percent of the contract management chiefs and 47% of the inspectors reported that they had attended other formal training courses. In addition, 62% of the section chiefs believed that their inspectors had attended other formal training courses. The U.S. Army Corps of Engineers

offered most of the other formal courses listed. Additional training courses included:

1. Quality Assurance Evaluation
2. Air Training Command mobile units
3. U.S. Navy courses
4. University extension courses
5. Local Code seminars
6. Roofing Industry Educational Institute course

Additional Training Requirements. These groups were asked where they believed additional inspector training is most needed and they responded:

	<u>Design Engineers</u>	<u>Contr Mgt Chiefs</u>	<u>Inspectors</u>
Civil/Structural works	23%	22%	18%
Mechanical works	20%	25%	26%
Electrical works	23%	18%	27%
Other	28%	27%	27%
None	6%	8%	2%

The responses from the three groups were fairly consistent and they did not point strongly to one particular area in need of additional training. The responses imply that additional training is equally needed in all three major areas. Nine of the eleven contract management chiefs who responded "other" noted additional training is most needed in all three disciplines. Also, the majority of the design engineers and inspectors who selected the "other" response indicated more training is needed in all three areas.

PROJECT IMAGE Recommendations. Several recommendations to improve the training for construction inspectors were suggested during the PROJECT IMAGE Construction Management Functional Review in June 1986. The recommendations are under study by the PROJECT IMAGE Working Group to determine their feasibility (19). They include:

1. Develop an aggressive on-the-job training program
2. Disseminate information about available audio-visual training aids
3. Provide better access to Corps of Engineer courses
4. Develop 5/7 level block in CDC course on intro to contract management QAE
5. Obtain quotas for the Contract Law course at Lowry AFB CO
6. Budget training funds
7. Provide joint Contract Management/Contracting training courses

Research Objective Four

To analyze the qualification requirements for inspectors, contract management chiefs and inspectors were asked to agree or disagree with questions concerning salary, classification, and professional certification.

Salary/Certification.

Statement: I believe that my salary is adequate.

Inspectors responded:

	<u>Strongly Disagree</u>	<u>Disagree</u>	<u>Neutral</u>	<u>Agree</u>	<u>Strongly Agree</u>
Inspectors	41%	33%	8%	16%	2%

Nearly 75% of the inspectors surveyed did not believe that their salary is adequate.

Statement: I believe that my position classification is accurate.

The responses from only the civilian inspectors were:

	<u>Strongly Disagree</u>	<u>Disagree</u>	<u>Neutral</u>	<u>Agree</u>	<u>Strongly Agree</u>
Inspectors	32%	28%	6%	31%	3%

Overall, the inspectors did not believe their classifications were accurate. However, the responses were not as strong as they were for the question concerning salary.

Statement: I feel that the position classification and salary for my inspectors permit me to attract competent people.

The contract management chiefs responded:

	<u>Strongly Disagree</u>	<u>Disagree</u>	<u>Neutral</u>	<u>Agree</u>	<u>Strongly Agree</u>
Contract Mgt Chiefs	51%	27%	10%	7%	5%

Over 75% of the responses were in disagreement with the statement. This was consistent with the inspectors' responses to the earlier question concerning salary.

#### Certification.

Statement: I am in favor of a certification program for inspectors.

Contract management chiefs and inspectors responded to the statement.

	<u>Strongly Disagree</u>	<u>Disagree</u>	<u>Neutral</u>	<u>Agree</u>	<u>Strongly Agree</u>
Contract Mgt Chiefs	2%	12%	29%	42%	15%
Inspectors	4%	8%	17%	30%	41%

Both groups appear to favor a certification program for inspectors. The responses from the inspectors were especially strong with over 75% in agreement.

One certification program is sponsored by the International Conference of Building Officials and many local governments require it (26). Obtaining this certification for a particular category (such as plumbing, electrical, etc.) requires passing a written exam for that category. The testable information comes primarily from various building codes.

Statement: I believe inspectors should attain semi-professional status together with a title of Engineering Technician.

The responses were:

	<u>Strongly Disagree</u>	<u>Disagree</u>	<u>Neutral</u>	<u>Agree</u>	<u>Strongly Agree</u>
Contract Mgt Chiefs	2%	5%	27%	46%	20%
Inspectors	5%	8%	10%	33%	44%

The results were very similar, but slightly more positive, than the previous question concerning certification.

## U. Conclusions and Recommendations

The purpose of this study is to determine the perception of the effectiveness of Air Force construction inspection. This was accomplished by examining four specific research objectives. The significance of the survey results and the practical implications of these results are presented in this chapter for each of the four research objectives.

The reader is reminded that the researcher has used the results of the study to make logical inferences rather than statistical inferences as explained in Chapter III.

### Research Objective One

The first research objective was to determine the perception design engineers, contract administrators, contract management chiefs, and inspectors have of the Air Force construction inspectors' job performance.

Based on the responses of the four groups surveyed, the job performance of the inspectors is perceived to be positive overall. The importance of the inspectors' role in a successful construction project and his/her attitude were given considerably high marks. However, the perception of the inspector's experience and capabilities were less positive. Approximately 25% of the individuals surveyed disagreed with the statement that inspectors are experienced and capable of properly inspecting work. Reasons for the dissatisfaction primarily included the lack of experience/training and the use

of temporary inspectors.

Factors effecting the inspectors' performance were also examined. One factor, inspector authority, resulted in differing opinions among the groups. While the contract administrators believed the limited authority the inspectors now have was sufficient, both the inspectors and contract management chiefs supported increased authority for the inspector. A PROJECT IMAGE Working Group is studying the feasibility of increasing the inspectors' authority. Another factor, workload, was considered somewhat excessive by both inspectors and contract management chiefs. However, the number of projects assigned to the majority of the inspectors appeared to be in-line with what an Air Force Civil Engineering and Services Evaluation Team report stated as acceptable (23). As a result of PROJECT IMAGE, a new manpower study for construction inspectors is being conducted (11).

Opinions concerning the last factor, constructability reviews, were quite positive. Over 80% of the inspectors performed constructability reviews and a strong majority of inspectors, design engineers, and contract management chiefs believed the inspectors generally make valuable recommendations as a result of these reviews.

Each of the groups, with the exception of the design engineers, ranked problems with poor drawings/specifications as the number one problem in their respective organizations. The design engineers cited problems with contractor personnel as their number one problem. It appears that solving the

problem of poor specifications/drawings will lead to solving many problems associated with construction projects. Problems associated with inspection personnel do not appear to be as significant as the other problems. Although contract administrators ranked problems with inspection personnel as their number two problem, both the design engineers and contract management chiefs considered this their least significant problem. Concerning the problem of "contractors cutting corners," less than one-third of the contract administrators believed this was a moderate to major problem. In contrast, over one-half of the respondents from civil engineering considered it to be a moderate to major problem.

The recommendations from the different groups for improving the quality of Air Force inspection were varied. Contract administrators, as well as inspectors, believed providing additional inspector training is the best recommendation. Additional training was the second choice for the other two groups. Design engineers believed that increasing engineer participation was most likely to improve inspection, while the top recommendation from contract management chiefs was to increase inspector grades.

#### Research Objective Two

The second research objective was to determine the perception of the inspectors' job knowledge. The majority of the individuals from the three civil engineering groups agreed that the Air Force inspectors are knowledgeable of current



construction techniques and practices. However, a significant number of respondents (20-25%) from each group disagreed with the statement. The percentages in disagreement are consistent with the percentages of individuals who did not believe that the inspectors had the experience and capability to properly inspect work in research objective one.

### Research Objective Three

The third research objective was to determine if the training programs for inspectors are adequate.

It does not appear that the training program for inspectors is adequate. Over three-fourths of the inspectors who attended the primary Air Force training course, the Contract Construction Inspectors Course, believed it was helpful training. However, less than half of the inspectors surveyed had attended the course. The primary reasons for nonattendance were nonavailability of course slots and too heavy of a workload to release inspectors. Only 22% of the inspectors had attended the Air Force Institute of Technology Contract Preparation and Management Course. Less than half of the inspectors surveyed had attended formal training courses other than these two Air Force courses. The other formal training courses most attended were generally offered by the U.S. Army Corps of Engineers. The in-house training programs at the bases were primarily on-the-job training programs for new personnel. However, it appears that a few of the bases may not have an on-the-job training program. The vast

majority of design engineers, contract management chiefs, and inspectors believed additional training is required. The responses from the three groups were fairly consistent and they did not point strongly to a particular area in need of additional training. The responses imply that additional training is essentially needed equally in civil/structural works, mechanical works, and electrical works. Several recommendations to improve the training for construction inspectors were suggested during the PROJECT IMAGE Functional Management Review in June 1986. The feasibility of these recommendations are under study by the PROJECT IMAGE Working Group (11).

#### Research Objective Four

The fourth research objective was to analyze the qualification requirements for inspectors. Overall, it appears that the qualifications for inspectors should be increased. In general, contract management chiefs and inspectors indicated support for higher pay/position levels along with increasing the professional status of the inspector.

One method of improving this inspector status is to require certification. Although this may be a worthwhile action in the long-term, the researcher believes there could be short-term problems. For example, it is possible that a significant number of the current inspectors may not be able to pass the certification exam. Also, salaries would most

likely have to increase to attract certified individuals.

### Concluding Summary

It appears that there is a very positive perception of the need for and attitude of inspectors. However, there are significant reservations about their capabilities and experience. The lack of inspector experience and training continually surfaced as a problem throughout the research effort. These reservations may be reversed by improving the inspector training opportunities and increasing inspector qualifications, such as requiring certification. Fortunately, these recommendations are under review by the PROJECT IMAGE Construction Management Functional Review Working Group. It is important to note that poor specifications/drawings, which are not the direct responsibility of the inspector, was identified as the most serious problem with construction inspection by the majority of the respondents.

One purpose of this study was to validate/invalidate the findings of a previous research study conducted by Captain Robert Upshur, Evaluation of Air Force Civil Engineering Inspection and the Inspector (23). The findings from both studies were very consistent with a few minor exceptions. Captain Upshur's study noted that engineers were inclined to believe that inspectors were not knowledgeable of current construction practices (23:28). In contrast, the engineers surveyed in this follow-up study believed that overall, the inspectors were knowledgeable of current construction

practices, even though there was a significant number of engineers in disagreement. There was also a difference in the study results concerning inspector authority. In the first study, only the inspectors believed that they had insufficient authority (23:52). In this follow-up study, both the inspectors and contract management chiefs believed the inspector's authority was insufficient, while the overall response from the design engineers was fairly neutral.

It should also be noted that Captain Upshur used the exam scores from MGT 425 to answer research objective two, while the the conclusions for this research objective in the follow-up study were based on survey results.

#### Recommendations

The two most significant issues that were identified, lack of inspector training and poor specifications/drawings, should be addressed immediately.

1. Better use of the two Air Force training courses, MGT 425 and the Contract Construction Inspector's Course, could improve the quality of construction inspection. Each course has approximately 125 quotas annually. Major commands should establish a priority program to insure all contract management chiefs have attended MGT 425 since approximately 50% have not attended. The remaining MGT 425 quotas should be allotted to design engineers in order to improve the development of specifications/drawings. The major commands should also establish a priority program to insure at least one inspector

from each base has attended the Contract Construction Inspector's Course at Sheppard AFB TX since 66% of the inspectors have not attended. There is approximately a five year backlog for current inspectors to receive this training.

2. Insure aggressive evaluation and implementation of Project IMAGE recommendations.

#### Recommendations For Further Study

The following are areas in which the researcher believes further research would be beneficial.

1. Examine the requirements/problems/benefits of government agencies who require certification in order to determine the advantages of certification.

2. Increasing design engineer participation throughout the life of a construction project was recommended as a method of improving construction. Further investigation of private/public organizations who involve the design engineer throughout the inspection process should reveal the advantages/disadvantages of the recommendation.

3. Further research into the actual knowledge of the inspector may provide valuable information. By administering a comprehensive test of the inspector's duties, individual problem areas may be identified and used to develop corrective measures directed toward improving the qualifications and performances of the inspector.

4. Study A.F. and non A.F. organizations where a team inspection concept is followed. In this approach to

inspection, inspectors only inspect one particular discipline within a project rather than inspecting the entire project. For example, an inspector with electrical expertise would only inspect the electrical portion of a project. This study should show the merits and problems to this concept of inspection.

5. Assign a contracting officer/administrator to the civil engineering organization at one of the Model Installation Program bases and study the advantages and disadvantages of this arrangement.

## Appendix A: Questionnaires



DEPARTMENT OF THE AIR FORCE  
AIR UNIVERSITY  
AIR FORCE INSTITUTE OF TECHNOLOGY  
WRIGHT-PATTERSON AIR FORCE BASE OH 45433-6583

15 APR 1986

REPLY TO LS (Capt Williams, AUTOVON 785-6569)

ATTN OF

SUBJECT: Survey on Construction Inspection

TO

1. The attached questionnaire was prepared by a researcher at the Air Force Institute of Technology (AFIT), Wright-Patterson AFB OH. The researcher will use the results of the survey to examine both the role of the civil engineering construction inspector and current inspector training courses to determine if his/her needs are being fulfilled.

2. Please take a few minutes to complete the questionnaire. You do not need to give your name. Just complete the questionnaire, seal the completed computer score sheet and questionnaire in the attached envelope, and mail it back to the researcher by 1 June 1986.

3. Although your participation in this survey is voluntary, your input will be extremely valuable in the overall evaluation of construction inspection throughout the Air Force. Thank you for your cooperation.

A handwritten signature in cursive script, reading "Larry L. Smith", is positioned above the typed name.

LARRY L. SMITH, Colonel, USAF  
Dean  
School of Systems and Logistics

3 Atch

1. Questionnaire
2. Computer Score Sheet
3. Return Envelope

SURVEY ON CONSTRUCTION INSPECTION  
PART I: QUESTIONNAIRE FOR CONTRACT ADMINISTRATOR

---

The following questionnaire has been developed to solicit your viewpoints on the inspection of construction contracts. Your inputs will be included in an AFIT thesis which will examine both the role of the Civil Engineering construction inspector and current inspector training courses to determine if his/her needs are being fulfilled.

Your participation in this survey is voluntary and anonymous; however, your cooperation is appreciated and will directly impact this research effort. Please provide an answer or comment for each question. Use a #2 pencil on the answer sheet to mark one letter for each question as shown below:

EXAMPLE:            78   ●            Correct  
                     79   X            Incorrect  
                     80   ✓            Incorrect

Make no extraneous marks or comments on the answer sheet. For each question requiring a comment, provide your comment in this booklet. On the answer sheet, do not fill in name, birth date, student number, etc. Simply start with Question #1.

Please return the completed questionnaire and answer sheet in the attached envelope within one week after receipt.

SECTION I

INSTRUCTIONS: Select the appropriate response. Use the attached answer sheet to mark your response.

1. My status is:
  - a. Enlisted
  - b. Officer
  - c. Civilian

2. My rank is:

	<u>Enlisted</u>	<u>Officer</u>	<u>Civilian</u>
a. E-1 - E-4	01		GS 7 or below
b. E-5	02		GS 8
c. E-6	03		GS 9
d. E-7	04		GS 10 or 11
e. E-8 or E-9	05		GS 12 or above



3. My EDUCATIONAL background is: (Highest completed)
- a. High school
  - b. Associate degree
  - c. Baccalaureate degree
  - d. Master's degree
  - e. Other \_\_\_\_\_
4. My professional certification is:
- a. Certified Professional Contracts Manager (NCMA)
  - b. Certified Associate Contracts Manager (NCMA)
  - c. Professional Designation in Contracts Management (AFIT/NCMA)
  - d. Other \_\_\_\_\_
  - e. None of the above
5. I have been in the A.F. Contracting career field for:
- a. less than 2 years
  - b. 2 years or more, but less than 4 years
  - c. 4 years or more, but less than 8 years
  - d. 8 years or more, but less than 12 years
  - e. more than 12 years
6. As an A.F. contract administrator, I have been administrating construction contracts for:
- a. less than 6 months
  - b. 6 months or more, but less than 1 year
  - c. 1 year or more, but less than 3 years
  - d. 3 years or more, but less than 5 years
  - e. more than 5 years
7. I have attended the Contract Preparation and Management Course, Mgt 425, at AFIT, School of Civil Engineering.
- a. Yes
  - b. No

## SECTION II

INSTRUCTIONS: Respond to each of the following statements according to the answer key shown at the top of the next page. Mark the response on the attached answer sheet. The terms construction and contracted work are used in the following questions. These terms refer to all Civil Engineering maintenance, repair, and minor construction projects which are accomplished by contractors; and inspected by Air Force inspectors. For each statement requiring a comment, provide your comment on this sheet.

- a. Strongly Disagree
- b. Disagree
- c. Neutral
- d. Agree
- e. Strongly Agree

8. Construction inspectors play a critical role in the overall success of a construction contract.  
(If you disagree, please explain.)
9. Many contractors have stated that they welcome inspection by competent A.F. inspectors because it assures the work is getting done with less chance of delays and costly errors. In my opinion, contractors at my base would agree. (If you disagree, please explain.)
10. Air Force inspectors are cooperative and interested in seeing that the contracted work is accomplished properly.
11. Contractors at my base generally agree that A.F. inspectors possess the experience necessary to properly inspect their work.  
(If you disagree, please explain.)
12. I find A.F. inspectors to be experienced and capable of properly inspecting construction work.  
(If you disagree, please explain.)
13. Air Force inspectors at times obligate the government without the authority to do so.
14. I believe the inspectors are given sufficient authority to carry out their duties.  
(If you disagree, please explain.)

### SECTION III

Statements #15 through #19 are some common inspection problems. Please evaluate each statement in terms of how much of a problem the statement is within your organization. Mark your response on the answer sheet using the key shown below:

- a. Major problem
- b. Moderate problem
- c. Minor problem
- d. Not a problem

- 15. Poor specifications and drawings.
- 16. Problems related to contractor personnel (i.e., lack of competent contractor personnel).
- 17. Problems related to inspection personnel (i.e., lack of competent inspectors).
- 18. Contractors cutting corners.
- 19. Other (Specify and evaluate) \_\_\_\_\_

Statements #20 through #24 are recommendations for improving the quality of A.F. construction inspection. Please evaluate each item in terms of how much you think these recommendations will improve the quality of construction inspections. Mark your response on the answer sheet using the key shown below:

- a. Very likely to improve inspections
- b. Slightly likely to improve inspections
- c. Neither likely nor unlikely to improve inspections
- d. Slightly unlikely to improve inspections
- e. Very unlikely to improve inspections

- 20. Increase design engineer participation.
- 21. Higher grade structure for the inspector.
- 22. More inspectors (i.e., reduced individual workload but increased inspection on all projects).
- 23. Additional inspector training.
- 24. Other (Specify and evaluate) \_\_\_\_\_

THANKYOU VERY MUCH FOR YOUR HELP!

SURVEY ON CONSTRUCTION INSPECTION  
PART II: QUESTIONNAIRE FOR DESIGN ENGINEERS

-----

The following questionnaire has been developed to solicit your viewpoints on the inspection of construction contracts. Your inputs will be included in an AFIT thesis which will examine both the role of the Civil Engineering construction inspector and current inspector training courses to determine if his/her needs are being fulfilled.

Your participation in this survey is voluntary and anonymous; however, your cooperation is appreciated and will directly impact this research effort. Please provide an answer or comment for each question. Use a #2 pencil on the answer sheet to mark one letter for each question as shown below:

EXAMPLE:	●	Correct
	X	Incorrect
	✓	Incorrect

Make no extraneous marks or comments on the answer sheet. For each question requiring a comment, provide your comment in this booklet. On the answer sheet, do not fill in name, birth date, student number, etc. Simply start with Question #1.

Please return the completed questionnaire and answer sheet in the attached envelope within one week after receipt.

SECTION I

INSTRUCTIONS: Select the appropriate response. Use the attached answer sheet to mark your response.

1. My status is:
- a. Enlisted
  - b. Officer
  - c. Civilian

2. My rank is:

	<u>Enlisted</u>	<u>Officer</u>	<u>Civilian</u>
a. E-1 - E-4		01	GS 7 or below
b. E-5		02	GS 8
c. E-6		03	GS 9
d. E-7		04	GS 10 or 11
e. E-8 or E-9		05	GS 12 or above

3. My EDUCATIONAL background is: (Highest completed)
- a. High school
  - b. Associate degree
  - c. Baccalaureate degree
  - d. Master's degree
  - e. Other \_\_\_\_\_
4. My professional certification is:
- a. Engineer-In-Training (EIT)/Interim Architect (IA)
  - b. Registered Professional Engineer (PE)/ Registered Architect (RA)
  - c. Other \_\_\_\_\_
  - d. None of the above
5. I have been in the A.F. Civil Engineering career field for:
- a. less than 2 years
  - b. 2 years or more, but less than 4 years
  - c. 4 years or more, but less than 8 years
  - d. 8 years or more, but less than 12 years
  - e. more than 12 years
6. I have been an A.F. designer for:
- a. less than 6 months
  - b. 6 months or more, but less than 1 year
  - c. 1 year or more, but less than 3 years
  - d. 3 years or more, but less than 5 years
  - e. more than 5 years
7. I have attended the Contract Preparation and Management Course, Mgt 415/425, at AFII, School of Civil Engineering.
- a. Yes
  - b. No
8. I am a:
- a. Mechanical Engineer
  - b. Electrical Engineer
  - c. Civil Engineer
  - d. Architect
  - e. OTHER \_\_\_\_\_

9. Do inspectors at your base make constructability reviews ( AFR 89-1, Atch 6 )?

- a. Yes
- b. No
- c. I don't know

10. I believe additional inspector technical training is most needed in

- a. Civil/structural works
- b. Mechanical works
- c. Electrical works
- d. Other \_\_\_\_\_
- e. No additional training is required

## SECTION II

INSTRUCTIONS: Respond to each of the following statements according to the answer key shown below. Mark the response on the attached answer sheet. The terms construction and contracted work are used in the following questions. These terms refer to all Civil Engineering maintenance, repair, and minor construction projects which are accomplished by contractors and inspected by Air Force inspectors. For each statement requiring a comment, provide your comment on this sheet.

- a. Strongly Disagree
- b. Disagree
- c. Neutral
- d. Agree
- e. Strongly Agree

11. Construction inspectors play a critical role in the overall success of a construction contract.  
(If you disagree, please explain)
  
12. Air Force inspectors are cooperative and interested in seeing that the contracted work is accomplished properly.
  
13. I find A.F. inspectors to be experienced and capable of properly inspecting construction work.
  
14. I believe the inspectors are given sufficient authority to carry out their duties.
  
15. Air Force inspectors are knowledgeable of current construction techniques and practices.
  
16. Air Force inspectors are capable of accurately interpreting design drawings and specifications.
  
17. Inspectors continually consult with the designer during the project's construction phase.
  
18. Inspectors generally make valuable recommendations as a result of their constructability reviews.

### SECTION III

Statements #19 through #23 are some common inspection problems. Please evaluate each statement in terms of how much of a problem the statement is within your organization. Mark your response on the answer sheet using the key shown below:

- a. Major problem
- b. Moderate problem
- c. Minor problem
- d. Not a problem

- 19. Poor specifications and drawings.
- 20. Problems related to contractor personnel (i.e., lack of competent contractor personnel).
- 21. Problems related to inspection personnel (i.e., lack of competent inspectors).
- 22. Contractors cutting corners.
- 23. Other (Specify and evaluate) \_\_\_\_\_

Statements #24 through #28 are recommendations for improving the quality of A.F. construction inspection. Please evaluate each item in terms of how much you think these recommendations will improve the quality of construction inspections. Mark your response on the answer sheet using the key shown below:

- a. Very likely to improve inspections
- b. Slightly likely to improve inspections
- c. Neither likely nor unlikely to improve inspections
- d. Slightly unlikely to improve inspections
- e. Very unlikely to improve inspections

- 24. Increase design engineer participation.
- 25. Higher grade structure for the inspector.
- 26. More inspectors (i.e., reduced individual workload but increased inspection on all projects).
- 27. Additional inspector training.
- 28. Other (Specify and evaluate) \_\_\_\_\_

THANK YOU VERY MUCH FOR YOUR HELP!



SURVEY ON CONSTRUCTION INSPECTION  
PART III: QUESTIONNAIRE FOR CONTRACT MANAGEMENT SUPERVISOR  
-----

The following questionnaire has been developed to solicit your viewpoints on the inspection of construction contracts. Your inputs will be included in an AFIT thesis which will examine both the role of the Civil Engineering construction inspector and current inspector training courses to determine if his/her needs are being fulfilled.

Your participation in this survey is voluntary and anonymous; however, your cooperation is appreciated and will directly impact this research effort. Please provide an answer or comment for each question. Use a #2 pencil on the answer sheet to mark one letter for each question as shown below:

EXAMPLE:            74   ●            Correct  
                              X            Incorrect  
                              ✓            Incorrect

Make no extraneous marks or comments on the answer sheet. For each question requiring a comment, provide your comment in this booklet. On the answer sheet, do not fill in name, birth date, student number, etc. Simply start with Question #1.

Please return the completed questionnaire and answer sheet in the attached envelope within one week after receipt.

SECTION I

INSTRUCTIONS: Select the appropriate response. Use the attached answer sheet to mark your response.

1. My status is:  
a. Enlisted  
b. Officer  
c. Civilian

2. My rank is:
- |               | <u>Enlisted</u> | <u>Officer</u> | <u>Civilian</u> |
|---------------|-----------------|----------------|-----------------|
| a. E-1 - E-4  | 01              |                | GS 7 or below   |
| b. E-5        | 02              |                | GS 8            |
| c. E-6        | 03              |                | GS 9            |
| d. E-7        | 04              |                | GS 10 or 11     |
| e. E-8 or E-9 | 05              |                | GS 12 or above  |

3. My EDUCATIONAL background is: (Highest completed)
- a. High school
  - b. Associate degree
  - c. Baccalaureate degree
  - d. Master's degree
  - e. Other \_\_\_\_\_
4. My professional certification is:
- a. Engineer-In-Training (EIT)/Interim Architect (IA)
  - b. Registered Professional Engineer (PE)/ Registered Architect (RA)
  - c. Other \_\_\_\_\_
  - d. None of the above
5. I have been in the A.F. Civil Engineering career field for:
- a. less than 2 years
  - b. 2 years or more, but less than 4 years
  - c. 4 years or more, but less than 8 years
  - d. 8 years or more, but less than 12 years
  - e. more than 12 years
6. I have supervised the Contract Management section for:
- a. less than 6 months
  - b. 6 months or more, but less than 1 year
  - c. 1 year or more, but less than 3 years
  - d. 3 years or more, but less than 5 years
  - e. more than 5 years
7. I have attended the Contract Preparation and Management Course, Mgt 415/425, at AFIT, School of Civil Engineering.
- a. Yes
  - b. No
8. I am a:
- a. Mechanical Engineer
  - b. Electrical Engineer
  - c. Civil Engineer
  - d. Architect
  - e. OTHER \_\_\_\_\_
9. I have attended the Contract Construction Inspectors Course at Sheppard AFB, TX.
- a. Yes
  - b. No

AD-A174 975

EVALUATION OF AIR FORCE CIVIL ENGINEERING CONSTRUCTION

2/2

INSPECTION(U) AIR FORCE INST OF TECH WRIGHT-PATTERSON

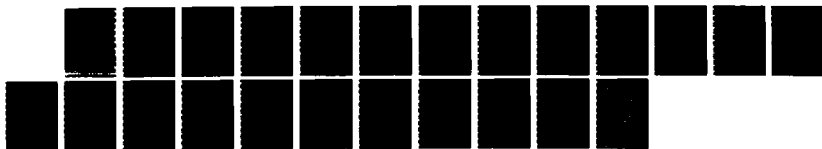
AFB OH SCHOOL OF SYST F L WILLIAMS SEP 86

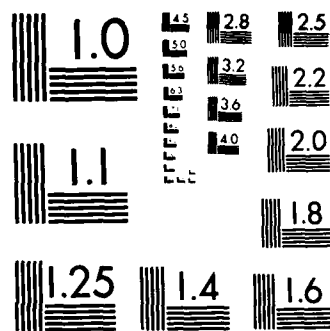
UNCLASSIFIED

AFIT/GEN/LSM/86S-29

F/G 13/2

NL





MICROCOPY RESOLUTION TEST CHART  
NATIONAL BUREAU OF STANDARDS-1963-A

10. I have attended other formal training courses?
- a. Yes
  - b. No
- (If yes, list the courses and the organizations providing the training)
11. My section has an "in-house" training program for construction inspectors.
- a. Yes
  - b. No
- ( If yes, give brief description of program )
12. Roughly, what percentage of your inspectors have attended the Contract Construction Inspector's Course at Sheppard AFB, TX?
- a. 0 - 25 percent
  - b. 26 - 50 percent
  - c. 51 - 75 percent
  - d. 76 - 100 percent
  - e. I don't know
13. If your inspectors have not attended the course, what is the primary reason?
- a. Not enough available course slots
  - b. Too heavy workload to release inspectors from my base
  - c. Not aware of course
  - d. Other (Specify) \_\_\_\_\_
  - e. I don't know
14. If your inspectors have attended the course, what is the primary reason?
- a. Slots are readily available
  - b. Workload is not too heavy to release inspectors from my base
  - c. Material covered in course contributes greatly to inspector's performance
  - d. Other (Specify) \_\_\_\_\_

15. Have your inspectors attended other formal training courses?
- a. Yes
  - b. No
  - c. I don't know
- (If yes, list the courses and the organizations providing the training)
16. What is the average number of Operations and Maintenance funded projects assigned to each inspector at any given time?
- a. 1 to 5
  - b. 6 to 9
  - c. 10 to 13
  - d. 14 or more
  - e. I don't know
17. What is the average total dollar value of all Operations and Maintenance funded projects assigned to each inspector at any given time?  
(mil - millions of dollars)
- a. .5 mil or less
  - b. .5 mil to 2 mil
  - c. 2 mil to 4 mil
  - d. Greater than 4 mil
  - e. I don't know
18. What is the average number of Military Construction Program projects assigned to each inspector for surveillance at any given time?
- a. 1
  - b. 2
  - c. 3
  - d. 4 or more
  - e. I don't know
19. What is the average total dollar value of all Military Construction Program projects assigned to each inspector for surveillance at any given time?  
(mil - millions of dollars)
- a. Less than 3 mil
  - b. 3 mil to 10 mil
  - c. 10 mil to 15 mil
  - d. 15 mil or more
  - e. I don't know

20. Do your inspectors make constructability reviews  
( AFR 89-1, Atch 6 )?
- a. Yes
  - b. No
  - c. I don't know
21. I believe additional inspector technical training  
is most needed in
- a. Civil/structural works
  - b. Mechanical works
  - c. Electrical works
  - d. Other \_\_\_\_\_
  - e. No additional training is required

## SECTION II

INSTRUCTIONS: Respond to each of the following statements according to the answer key shown below. Mark the response on the attached answer sheet. The terms construction and contracted work are used in the following questions. These terms refer to all Civil Engineering maintenance, repair, and minor construction projects which are accomplished by contractors and inspected by Air Force inspectors. For each statement requiring a comment, provide your comment on this sheet.

- a. Strongly Disagree
- b. Disagree
- c. Neutral
- d. Agree
- e. Strongly Agree

22. Construction inspectors play a critical role in the overall success of a construction contract.  
(If you disagree, please explain)
23. I feel that my inspectors have too heavy a workload.
24. My inspectors are experienced and capable of properly inspecting contracted work.
25. I feel that the position classification and salary for my inspectors permit me to attract competent people.

- a. Strongly Disagree
- b. Disagree
- c. Neutral
- d. Agree
- e. Strongly Agree

- 26. I am in favor of a certification program for inspectors.
- 27. I believe inspectors should attain semi-professional status together with a title of Engineering Technician.
- 28. My inspectors are knowledgeable of current construction techniques and practices.
- 29. I believe the authority given to inspectors in accordance with DOD and A.F. regulations is adequate.
- 30. I believe the training provided by the Contract Preparation and Management Course, Mgt 425, AFIT, School of Civil Engineering, is helpful training for inspectors.  
(If you disagree, please explain)
- 31. I believe the training provided by the Contract Construction Inspector's Course #J3AZR55000 at Sheppard AFB, TX is helpful training for most inspectors.  
(If you disagree, please explain)
- 32. These two courses provide most of the training construction inspectors require.  
(If you disagree, please explain)
- 33. I believe the use of an "in-house" training program provides sufficient training for construction inspectors.
- 34. Inspectors generally make valuable recommendations as a result of their constructability reviews.



### SECTION III

Statements #35 through #39 are some common inspection problems. Please evaluate each statement in terms of how much of a problem the statement is within your organization. Mark your response on the answer sheet using the key shown below:

- a. Major problem
- b. Moderate problem
- c. Minor problem
- d. Not a problem

- 35. Poor specifications and drawings.
- 36. Problems related to contractor personnel (i.e., lack of competent contractor personnel).
- 37. Problems related to inspection personnel (i.e., lack of competent inspectors).
- 38. Contractors cutting corners.
- 39. Other (Specify and evaluate) \_\_\_\_\_

Statements #40 through #44 are recommendations for improving the quality of A.F. construction inspection. Please evaluate each item in terms of how much you think these recommendations will improve the quality of construction inspections. Mark your response on the answer sheet using the key shown below:

- a. Very likely to improve inspections
- b. Slightly likely to improve inspections
- c. Neither likely nor unlikely to improve inspections
- d. Slightly unlikely to improve inspections
- e. Very unlikely to improve inspections

- 40. Increase design engineer participation.
- 41. Higher grade structure for the inspector.
- 42. More inspectors (i.e., reduced individual workload but increased inspection on all projects).
- 43. Additional inspector training.
- 44. Other (Specify and evaluate) \_\_\_\_\_

THANK YOU VERY MUCH FOR YOUR HELP!

SURVEY ON CONSTRUCTION INSPECTION  
PART IV: QUESTIONNAIRE FOR CONSTRUCTION INSPECTOR  
-----

The following questionnaire has been developed to solicit your viewpoints on the inspection of construction contracts. Your inputs will be included in an AFIT thesis which will examine both the role of the Civil Engineering construction inspector and current inspector training courses to determine if his/her needs are being fulfilled.

Your participation in this survey is voluntary and anonymous; however, your cooperation is appreciated and will directly impact this research effort. Please provide an answer or comment for each question. Use a #2 pencil on the answer sheet to mark one letter for each question as shown below:

EXAMPLE:

<input checked="" type="radio"/>	Correct
<input type="radio"/>	Incorrect
<input checked="" type="radio"/>	Incorrect

Make no extraneous marks or comments on the answer sheet. For each question requiring a comment, provide your comment in this booklet. On the answer sheet, do not fill in name, birth date, student number, etc. Simply start with Question #1.

Please return the completed questionnaire and answer sheet in the attached envelope within one week after receipt.

SECTION I

INSTRUCTIONS: Select the appropriate response. Use the attached answer sheet to mark your response.

1. My status is:
- a. Enlisted
  - b. Officer
  - c. Civilian

2. My rank is:

	<u>Enlisted</u>	<u>Officer</u>	<u>Civilian</u>
a. E-1 - E-4	01		GS 7 or below
b. E-5	02		GS 8
c. E-6	03		GS 9
d. E-7	04		GS 10 or 11
e. E-8 or E-9	05		GS 12 or above

3. My EDUCATIONAL background is: (Highest completed)
- a. High school
  - b. Associate degree
  - c. Baccalaureate degree
  - d. Master's degree
  - e. Other \_\_\_\_\_
4. My professional certification is:
- a. Engineer-In-Training (EIT)/Interim Architect (IA)
  - b. Registered Professional Engineer (PE)/ Registered Architect (RA)
  - c. Other \_\_\_\_\_
  - d. None of the above
5. I have been in the A.F. Civil Engineering career field for:
- a. less than 2 years
  - b. 2 years or more, but less than 4 years
  - c. 4 years or more, but less than 8 years
  - d. 8 years or more, but less than 12 years
  - e. more than 12 years
6. I have been an A.F. construction inspector for:
- a. less than 6 months
  - b. 6 months or more, but less than 1 year
  - c. 1 year or more, but less than 3 years
  - d. 3 years or more, but less than 5 years
  - e. more than 5 years
7. I have attended the Contract Preparation and Management Course, Mgt 415/425, at AFIT, School of Civil Engineering.
- a. Yes
  - b. No
8. I have attended the Contract Construction Inspector's Course #J3AZR55000 at Sheppard AFB, TX.
- a. Yes
  - b. No

9. If the answer to question 8 is no, what is the primary reason you have not attended the course?

- a. Not enough available course slots
- b. Too heavy workload to release inspectors from your base
- c. Material covered in course is not worthwhile
- d. Not aware of course
- e. Other (Specify) \_\_\_\_\_

10. I have attended other formal training courses for construction inspection.

- a. Yes
- b. No

(If you answered "yes", list the courses and the organizations providing the training.)

11. My base has an "in-house" training program.

- a. Yes
- b. No

( If yes, give brief explanation of program )

12. My duties are limited to:

- a. Construction inspection only
- b. Quality Assurance Evaluation (Service Contracts) only
- c. Both construction inspection and Quality Assurance Evaluation
- d. Other \_\_\_\_\_

13. The average number of Operations and Maintenance funded projects assigned to me at any given time is:

- a. 1 to 5
- b. 6 to 9
- c. 10 to 13
- d. 14 or more

14. The average total dollar value of Operation and Maintenance funded projects normally assigned to me at any given time is: (mil - millions of dollars)
- a. less than .5 mil
  - b. .5 mil to 2 mil
  - c. 2 mil to 4 mil
  - d. 4 mil or more
15. The average number of Military Construction Program projects assigned to me at any given time for surveillance is
- a. 1
  - b. 2
  - c. 3
  - d. 4 or more
16. The average total dollar value of Military Construction Program projects assigned to me for surveillance at any given time is: (mil - millions of dollars)
- a. Less than 3 mil
  - b. 3 mil to 10 mil
  - c. 10 mil to 15 mil
  - d. 15 mil or more
17. The type of construction I am most familiar with is
- a. Electrical
  - b. Mechanical
  - c. Civil Works
  - d. Other \_\_\_\_\_
18. As an inspector, I make constructability reviews ( AFR 89-1, Atch 6 )
- a. Yes
  - b. No
19. I believe additional inspector technical training is most needed in
- a. Civil/structural works
  - b. Mechanical works
  - c. Electrical works
  - d. Other \_\_\_\_\_
  - e. No additional training is required

## SECTION II

INSTRUCTIONS: Respond to each of the following statements according to the answer key shown below. Mark the response on the attached answer sheet. The terms construction and contracted work are used in the following questions. These terms refer to all Civil Engineering maintenance, repair, and minor construction projects which are accomplished by contractors and inspected by Air Force inspectors. For each statement requiring a comment, provide your comment on this sheet.

- a. Strongly Disagree
- b. Disagree
- c. Neutral
- d. Agree
- e. Strongly Agree

- 20. As an inspector, I believe my workload is too heavy.
- 21. I believe that my position classification is accurate.
- 22. I believe that my salary is adequate.
- 23. I am in favor of a certification program for inspectors.
- 24. I believe inspectors should attain semi-professional status together with a title of Engineering Technician.
- 25. I believe the authority given to inspectors in accordance with DOD and A.F. regulations is adequate.
- 26. I believe the training provided by the Contract Preparation and Management Course, Mgt 425, AFIT School of Civil Engineering, is helpful training for all inspectors.  
(if you disagree, please explain)

- a. Strongly Disagree
- b. Disagree
- c. Neutral
- d. Agree
- e. Strongly Agree

27. I believe the training provided by the Contract Construction Inspector's Course #J3A2R55000 at Sheppard AFB, TX is helpful training for most inspectors.  
(If you disagree, please explain)
28. These two courses provide most of the training construction inspectors require.  
(If you disagree, please explain)
29. I believe the use of an "in-house" training program provides sufficient training for construction inspectors.
30. I believe inspectors generally make valuable recommendations as a result of their constructability reviews.
31. I find the technical knowledge level for inspectors in general to be high.

### SECTION III

Statements #32 through #36 are some common inspection problems. Please evaluate each statement in terms of how much of a problem the statement is within your organization. Mark your response on the answer sheet using the key shown below:

- a. Major problem
- b. Moderate problem
- c. Minor problem
- d. Not a problem

- 32. Poor specifications and drawings.
- 33. Problems related to contractor personnel (i.e., lack of competent contractor personnel).
- 34. Problems with job conditions (i.e., low salaries attracting underqualified inspectors and heavy inspector workloads).
- 35. Contractors cutting corners.
- 36. Other (Specify and evaluate) \_\_\_\_\_

Statements #37 through #41 are recommendations for improving the quality of A.F. construction inspection. Please evaluate each item in terms of how much you think these recommendations will improve the quality of construction inspections. Mark your response on the answer sheet using the key shown below:

- a. Very likely to improve inspections
- b. Slightly likely to improve inspections
- c. Neither likely nor unlikely to improve inspections
- d. Slightly unlikely to improve inspections
- e. Very unlikely to improve inspections

- 37. Increase design engineer participation.
- 38. Higher grade structure for the inspector.
- 39. More inspectors (i.e., reduced individual workload but increased inspection on all projects).
- 40. Additional inspector training.
- 41. Other (Specify and evaluate) \_\_\_\_\_

THANK YOU VERY MUCH FOR YOUR HELP!



Appendix B: Survey Distribution Letters



DEPARTMENT OF THE AIR FORCE  
AIR UNIVERSITY  
AIR FORCE INSTITUTE OF TECHNOLOGY  
WRIGHT-PATTERSON AIR FORCE BASE OH 45433-6583

28 APR 1986

REPLY TO LS (Capt Williams, AUTOVON 785-6569)  
ATTN OF

SUBJECT Survey on Construction Inspection

TO

1. The attached questionnaires were prepared by a researcher at the Air Force Institute of Technology (AFIT), Wright-Patterson AFB, Ohio. The researcher will use the results of the survey to examine both the role of the civil engineering construction inspector and current inspector training courses to determine if his/her needs are being fulfilled.

2. Please distribute the attached questionnaires to the following individuals: Chief, Contract Management, three randomly selected design engineers, and three randomly selected construction inspectors. Individual responses will be returned anonymously. Responses are requested by 1 June 1986.

3. Although participation in this survey is voluntary, inputs from your personnel will be extremely valuable in the overall evaluation of construction inspection throughout the Air Force. Thank you for your cooperation.

A handwritten signature in cursive script, reading "Larry L. Smith", is positioned above the typed name.

LARRY L. SMITH, Colonel, USAF  
Dean  
School of Systems and Logistics

3. Atch  
1. Chief, Contract Mgt  
Questionnaire  
2. Design Engineer  
Questionnaire (3 ea)  
3. Inspector  
Questionnaire (3 ea)



DEPARTMENT OF THE AIR FORCE  
AIR UNIVERSITY  
AIR FORCE INSTITUTE OF TECHNOLOGY  
WRIGHT-PATTERSON AIR FORCE BASE OH 45433-6583

REPLY TO LS (Capt Williams, AUTOVON 785-6569)  
ATTN OF

28 APR 1986

SUBJECT Survey on Construction Inspection

TO:

1. The attached questionnaires were prepared by a researcher at the Air Force Institute of Technology (AFIT), Wright-Patterson AFB, Ohio. The researcher will use the results of the survey to examine both the role of the civil engineering construction inspector and current inspector training courses to determine if his/her needs are being fulfilled.
2. Please select three contract administrators who are responsible for construction contracts to complete the questionnaires. Individual responses will be returned anonymously. Responses are requested by 1 June 1986.
3. Although participation in this survey is voluntary, inputs from your personnel will be extremely valuable in the overall evaluation of construction inspection throughout the Air Force. Thank you for your cooperation.

*Larry L. Smith*  
LARRY L. SMITH, Colonel, USAF  
Dean  
School of Systems and Logistics

1 Atch  
Questionnaire (3 ea)

STRENGTH THROUGH KNOWLEDGE

Appendix C: List of Air Force Bases Surveyed

Air Training Command

Chanute AFB IL  
Columbus AFB MS  
Laughlin AFB TX  
Lowry AFB CO  
Mather AFB CA  
Reese AFB TX  
Sheppard AFB TX  
Williams AFB AZ

Air University

Maxwell AFB AL

Air Force Logistics Command

Hill AFB UT  
McClellan AFB CA  
Robins AFB GA  
Tinker AFB OK

Military Airlift Command

Andrews AFB MD  
Charleston AFB SC  
Dover AFB DE  
Kirtland AFB NM  
Little Rock AFB AR  
McChord AFB WA  
McGuire AFB NJ  
Norton AFB CA  
Scott AFB IL  
Travis AFB CA

Air Force Systems Command

Edwards AFB CA  
Hanscom AFB MA  
Patrick AFB FL  
Eglin AFB FL

Space Command

Peterson AFB CO

Tactical Air Command

Bergstrom AFB TX  
Cannon AFB NM  
Davis-Monthon AFB AZ  
George AFB CA  
Holloman AFB NM  
Homestead AFB FL  
Langley AFB VA  
Luke AFB AZ  
MacDill AFB FL  
Myrtle Beach AFB SC  
Seymour Johnson AFB NC  
Shaw AFB SC  
Tyndall AFB FL

Strategic Air Command

Barksdale AFB LA  
Beale AFB CA  
Blytheville AFB AR  
Castle AFB CA  
Dyess AFB TX  
Ellsworth AFB SD  
F.E. Warren AFB WY  
Grand Forks AFB ND  
Griffiss AFB NY  
K.I. Sawyer AFB MI  
Loring AFB ME  
Malmstrom AFB MT  
March AFB CA  
Minot AFB ND  
Pease AFB NH  
Plattsburg AFB NY  
Vandenberg AFB CA  
Whiteman AFB MO

## Bibliography

1. Board of Contract Appeals Decisions. 75-2. Chicago: Commerce Clearing House Inc., 1975.
2. Board of Contract Appeals Decisions. 76-2. Chicago: Commerce Clearing House Inc., 1976.
3. Committee on Inspection of the Construction Division. "Recommended Standards for the Responsibility, Authority, and Behavior of the Inspector," Journal of the Construction Division, Proceedings of the American Society of Civil Engineers, 102: 359-364 (June 1975).
4. Department of the Air Force. "A Guide for the Development of the Attitude and Opinion Survey." HQ USAF/ACM, Washington, October 1974.
5. Department of the Air Force. Design and Construction Management. AFR 89-1. Washington: HQ USAF, 20 June 1978.
6. Department of the Air Force. 1985-1987 Catalog Air Force Institute of Technology. Washington: Government Printing Office, 1984.
7. Emory, C. William. Business Research Methods (Third Edition). Homewood IL: Richard Irwin, Inc., 1985.
8. Engineering Management Study of the Air Force Design and Construction Management Establishment. Contract F49642-83-C-0222 with Performance, Incorporated, Fairfax VA, 21 December 1984.
9. Goode, William J. Methods in Social Research. New York: McGraw-Hill Compay, Inc., 1952.
10. Information distributed during the Project IMAGE Construction Management Functional Review. Air Force Engineering and Services Center, Tyndall AFB FL, 2 June 1986.
11. Jefferson, Msgr Robert L., Member of the 1986 Project IMAGE Construction Management Functional Review. Briefing to AFIT MGT 425 students. Air Force Institute of Technology (AU), Wright-Patterson AFB OH, 18 June 1986.

12. Manzi, Joseph E. "Construction Inspection: Improving the Benefits Received," Proceedings of the Symposium on Professional Inspection of Construction. 12. American Society of Civil Engineers, New York, 4 October 1984.
13. Maske, Capt Carol R., Personnel Survey Branch. Telephone interview. Air Force Military Personnel Center, Randolph AFB TX, 17 March 1986.
14. Merrill, 1st Lt William E. and Capt Lindin J. Torchia. Air Force Construction Disputes: An Analysis of Armed Services Board of Contract Appeals Cases to Identify Dispute Types and Causes. MS thesis, LSSR 88-82. School of Systems and Logistics, Air Force Institute of Technology (AU), Wright-Patterson AFB OH, September 1982 (AD-A122988).
15. O'Brien, James. Construction Inspection Handbook (Second Edition). New York: Van Nostrand Reinhold Company, 1983.
16. Osgood, Douglas C., Instructor, Contract Preparation and Management Course MGT 425. Personal interview. School of Civil Engineering, Air Force Institute of Technology (AU), Wright-Patterson AFB OH, 18 July 1986.
17. Patterson, Maj Daniel E. and Capt William C. Mason. "Managing Construction Management," Engineering and Services Quarterly, 26-29 (May 1978).
18. Poloskey, Capt Thomas E., Manpower Specialist. Provided unit manning computer printout. Air Force Engineering and Services Center, Tyndall AFB FL, September 1985.
19. "Recommendations For Project IMAGE," Construction Management Functional Review. Air Force Engineering and Services Center, Tyndall AFB FL, June 1986.
20. SPSSx. New York: McGraw-Hill, 1984.
21. Task Committee on Inspection of the Construction Division. "Summary Report of Questionnaire of Construction Inspection," Journal of the Construction Division, Proceedings of the American Society of Civil Engineers, 98: 219-234 (September 1972).
22. Taylor, Charles. Course Material in Contract Inspector's Course #J3A2R55070. Sheppard Air Training Center, Air Training Command (ATC), Sheppard AFB TX, 7 August 1985.

23. Upshur, Capt Robert A, Jr. Evaluation of Air Force Civil Engineering Construction Inspection and the Inspector. MS thesis. School of Systems and Logistics, Air Force Institute of Technology (AU), Wright-Patterson AFB OH, September 1985.
24. Upshur, Capt Robert A, Jr. Personal correspondence. School of Systems and Logistics, Air Force Institute of Technology (AU), Wright-Patterson AFB OH, 15 August 1985.
25. Walstad, Paul J., and Joseph H. Kasimer. "Construction Claims: Investigating and Presenting Them," The Military Engineer, 482: 376-380 (September-October 1982).
26. Wolfe, Duane E., Engineer and Member of the International Conference of Building Officials. Telephone interview. 4392 AEROSG/DEED, Vandenberg AFB CA, 19 August 1986.

UITA

Captain Franklin L. Williams was born on 8 November 1954 in Honolulu, Hawaii. He graduated from Enid High School in Enid, Oklahoma, in 1973 and attended Oklahoma State University from which he received the degree of Bachelor of Science in Civil Engineering in May 1978. Upon graduation, he received a commission in the USAF through the ROTC program. He was called to active duty in September 1978 as Chief, Readiness and Logistics, in the 443 Civil Engineering Squadron at Altus AFB OK. In January 1981, Captain Williams was reassigned to Headquarters United States Air Forces in Europe as a civil engineering staff officer. Here, he was the project manager for the design of facilities for the new Ground Launched Cruise Missile base in Florennes, Belgium. In March 1984, Captain Williams was assigned as the first Chief, Engineering and Environmental Planning, at Florennes AB, Belgium, and he served there until entering the School of Systems and Logistics, Air Force Institute of Technology, in May 1985.

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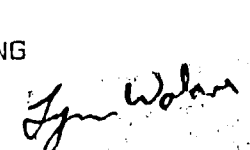
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This study is an investigation to determine the perception of the effectiveness of Air Force construction inspection. In a 1985 study, the researcher identified excessive inspector workload, insufficient inspector training, and low inspector qualifications as potential problem areas for construction inspectors. However, due to limited data collection, the findings were not conclusive. This study attempted to validate/invalidate the previous findings by analyzing the returned opinion surveys from a larger sample population. The four research objectives were: 1) Determine the perceptions of the Air Force inspectors' job performance, 2) Determine the perception of the inspectors' job knowledge, 3), Determine if the training programs for the inspectors are adequate, and 4) Analyze the qualification requirements for inspectors. The opinion surveys were given to inspectors, inspector supervisors, design engineers, and contract administrators. The survey responses showed that the job performance of the inspectors is perceived to be positive overall. However, a significant number of individuals surveyed were concerned with the inspectors' experience, job knowledge, and capability to properly inspect the work. The results also showed that the training program for inspectors may not be adequate. Although the majority of the inspectors who attended the Contract Construction Inspectors Course believed it was helpful training, less than half of the inspectors surveyed had attended the course. Both contract administrators and inspectors noted that additional inspector training was the most likely recommendation to improve the quality of inspection. Finally, contract management chiefs and inspectors believed that the qualifications for inspectors, such as requiring certification, should be increased.

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